Endangered Species Act - Section 7 Consultation
and
Magnuson-Stevens Act
Essential Fish Habitat Consultation

BIOLOGICAL OPINION

Columbia River Federal Navigation
Channel Improvements Project

Agency: U.S. Army Corps of Engineers - Portland District

Consultation Conducted By: National Marine Fisheries Service,
Northwest Region

Date Issued: May 20, 2002

Issued by: For Michael R Crouse
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Regional Administrator

Refer to: OHB1999-0270-RI

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1. OBJECTIVES

1.1 Introduction

The Endangered Species Act (ESA) (16 USC 1531-1544), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitat upon which they depend. Section 7(a)(2) of the ESA requires that Federal agencies consult with the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries (NMFS) to insure that any action funded, authorized or carried out by Federal agencies is not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitats.

This document is the product of a consultation pursuant to section 7(a)(2) of the ESA between the NMFS and the U.S. Army Corps of Engineers (Corps) commenced in August, 2000, on the Columbia River Federal navigation Channel Improvements Project (Project). The Corp's issued a biological assessment for the Project, dated December 28, 2001, and amended that document in a letter dated April 15, 2002. The 2001 BA and amendment letter describe the proposed action for the Project. These Corps documents are herein referred to as the 2001 BA.

The proposed action consists of improvements to the main Columbia River navigation channel, ecological restoration activities in the Lower Columbia River, and other associated activities. The channel improvements include the deepening of the main navigation channel in the Lower Columbia River and improvements to ship turning basins. Construction and maintenance of seven ship berths in the Lower Columbia River are considered interrelated and/or interdependent actions. The other activities include an ecosystem restoration initiative, a monitoring and evaluation program, a research program, and an adaptive management process governing the implementation of the proposed action. The purpose of the proposed action is to remove existing depth constraints to vessel movements and thereby improve access to the ports of the Lower Columbia River for deep draft vessels, and to restore ecological functions in the Lower Columbia River for ESA-listed salmonids and other fish and wildlife species. Chapter 2.1 describes the proposed action in further detail.

The purpose of this consultation is to evaluate whether the proposed action will jeopardize the continued existence of ESA-listed salmonids under the ESA or result in the destruction or adverse modifications of designated critical habitat. The species considered in this consultation are listed in Table 1.1.

The Corps has indicated in their 2001 BA that the Project is likely to adversely affect ESA-listed salmonids, and not likely to adversely affect northern sea lions (a.k.a. steller sea lions). NMFS concurs with the Corps determination for steller sea lions.

Table 1.1 References for Additional Background on Listing Status, Biological Information, and Critical Habitat Elements for the ESA-listed and Candidate Species Considered in this Consultation.

Species	Listing Status	Critical Habitat	Protective Regulations	Biological Information, Historical Population Trends
Columbia River chum salmon	March 25, 1999; 64 FR 14508, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Johnson *et al.* 1997; Salo 1991
Lower Columbia River steelhead	March 19, 1998; 63 FR 13347, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Busby *et al.* 1995; 1996
Middle Columbia River steelhead	March 25, 1999; 64 FR 14517, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Busby *et al.* 1995; 1996
Upper Columbia River steelhead	August 18, 1997; 62 FR 43937, Endangered	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Busby *et al.* 1995; 1996
Upper Willamette River steelhead	March 25, 1999 64 FR 14517, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Busby *et al.* 1995; 1996
Snake River Basin steelhead	August 18, 1997; 62 FR 43937, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Busby *et al.* 1995; 1996
Snake River sockeye salmon	November 20, 1991; 56 FR 58619, Endangered	December 28, 1993; 58 FR 68543	November 20, 1991; 56 FR 58619	Waples *et al.* 1991a; Burgner 1991
Lower Columbia River chinook salmon	March 24, 1999; 64 FR 14308, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Myers *et al.*1998; Healey 1991
Upper Columbia River spring-run chinook salmon	March 24, 1999; 64 FR 14308, Endangered	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Myers *et al.*1998; Healey 1991
Upper Willamette River chinook salmon	March 24, 1999; 64 FR 14308, Threatened	February 16, 2000; 65 FR 7764	July 10, 2000; 65 FR 42422	Myers *et al.*1998; Healey 1991
Snake River spring/summer-run chinook salmon	April 22, 1992; 57 FR 14653, Threatened[1]	December 28, 1993; 58 FR 68543[1]	April 22, 1992; 57 FR 14653	Matthews and Waples 1991; Healey 1991
Snake River fall chinook salmon	April 22, 1992; 57 FR 14653, Threatened[2]	December 28, 1993; 58 FR 68543	April 22, 1992; 57 FR 14653	Waples *et al.* 1991b; Healey 1991

[1]This corrects the original designation of 12/28/93 (FR 68543) by excluding areas above Napias Creek Falls, a naturally impassable barrier.

[2]Also see, 6/3/92; 57 FR 23458, correcting the original listing decision of by refining ESU ranges.

Steller Sea Lion (Northern Sea Lion)	August 27, 1993; 58 FR 45269, Threatened	August 27, 1993; 58 FR 45269, Threatened	January 8, 2002; 67 FR 956; amended & corrected; May 1, 2002; 67 FR 21600	Bic Lo

1.2 Relationship to Other Biological Opinions

NMFS has previously consulted with the Corps on the maintenance dredging activities in the Columbia River. These biological opinions demonstrate NMFS' involvement and understanding of Columbia River dredging issues, and serve as a record of issues that we have raised during consultations on previous dredging actions.

The consultations previously conducted on the Corps' Operation and Maintenance Dredging activities include:

- An August 1, 1991, informal consultation for use of Interim Area D Estuarine Disposal Site in Clatsop County, Oregon;
- A February 25, 1992, informal consultation for construction of the Wahkiakum Ferry Channel at Puget Island, Washington;
- A March 5, 1992, informal consultation for emergency dredging sites in the Columbia River;
- A December 11, 1992, informal consultation for expansion of Columbia River dredged material disposal sites;
- A November 5, 1993, informal consultation for Dungeness crab entrainment studies in Baker Bay, Washington;
- A December 22, 1993, formal consultation on Columbia River operation and maintenance dredging;
- A September 14, 1994, reinitiation of the December 22, 1993 formal consultation to address designated critical habitat;
- An April 6, 1996, informal consultation on hopper and pipeline dredging in the Columbia River;
- A September 22, 1995, formal consultation on repair of pile dikes in the Lower Columbia River;
- A July 25, 1996, reinitiation of the September 22 formal consultation to address additional pile dikes;
- An August 2, 1996, informal consultation on replacement of a navigational aid in the Lower Columbia River;
- A May 28, 1998, informal consultation for the maintenance dredging program to address listing of Snake River and Upper Columbia River steelhead;
- A May 27,1999, informal consultation to begin dredging operations at the mouth of the Columbia River; and
- A September 15, 1999, formal consultation on operation and maintenance dredging from John Day Dam to the mouth of the Columbia River.

NMFS also previously completed a December 16, 1999, biological opinion on the Corps' proposed channel deepening project, which NMFS subsequently withdrew. This led to initiation of the current consultation. This biological opinion (Opinion) supercedes our December 16, 1999, biological opinion. Further background on the earlier consultation associated with this project is described in Section 2.2 of this Opinion.

Finally, in December, 2000, NMFS and the FWS issued a multi-species biological opinion on the Corps' operation of the Federal Columbia River Hydropower System (FCRPS) which recognized that "Estuarine protection and restoration must play vital roles in rebuilding the productivity of listed salmon and steelhead throughout the Columbia River basin." Included in the FCRPS biological opinion are reasonable and prudent alternative (RPA) action items Nos. 158 - 163 and Nos. 194 - 197 that specifically address estuary research, conservation, and restoration actions that support the survival and recovery of ESA-listed salmonids. These FCRPS RPA action items are referred to in the Incidental Take Statement of this Opinion in order to better integrate ESA compliance measures for these two Corps projects.

1.3 Application of ESA Section 7(a)(2) Standards: Jeopardy Analysis Framework

Section 7 of the ESA requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. The NMFS' ESA implementing regulations define "jeopardize the existence of" as:

> To engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of listed species in the wild by reducing the reproduction, numbers or distribution of that species.

The NMFS' ESA implementing regulations define "destruction or adverse modification" of critical habitat as:

> A direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a ESA-listed salmonids. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical.

This Opinion evaluates the effects of the proposed action on ESA-listed salmonids by applying the standards of section 7(a)(2), as interpreted through joint NMFS/FWS regulations and policies, using the best scientific and commercial data available. To achieve the objectives of this Opinion, NMFS uses a five-step approach for applying the ESA section 7(a)(2) standards to Pacific salmon:

- Define the biological requirements and current status of each ESA-listed salmonids.
- Evaluate the relevance of the environmental baseline to the species' current status.
- Determine the effects of the proposed or continuing action on ESA-listed salmonids.
- Determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the continuing action, the effects of the environmental baseline, and any cumulative effects, and considering measures for survival and recovery specific to other life stages.
- Identify RPAs to a proposed or continuing action when that action is likely to jeopardize the continued existence of an ESA-listed species or destroy or adversely modify its critical habitat.
- This step is relevant only when the conclusion of the previously described analysis is that the proposed action would jeopardize ESA-listed salmonids. If the conclusion is no-jeopardy, then NMFS will identify

conservation measures that include reasonable and prudent measures designed to reduce incidental take of ESA-listed species and if appropriate, conservation recommendations.

These steps are described below.

1.3.1 Define the Biological Requirements and Current Status of ESA-Listed Salmonids

To fully consider the current status of the ESA-listed salmonids (50 CFR Section 402.14(g)(2)), NMFS evaluates the species-level biological requirements of a species, subspecies or distinct population segment. For Pacific salmonids, NMFS evaluates species-level biological requirements as they relate to the distinct population segment, or Evolutionary Significant Unit (ESU).

NMFS evaluates the biological requirements and the status of ESA-listed salmonids for both the ESU and the action area. For the purposes of this reinitiation of consultation, the biological requirements are described as the habitat conditions necessary to ensure the species' continued existence, expressed in terms of physical, chemical and biological parameters (NMFS 1999a). NMFS also considers the current status of each species, taking into account population size, trends, distribution and genetic diversity.

The ESA-listed salmonid's biological requirements may be described in terms of the habitat conditions necessary to ensure the species' continued existence (*i.e.*, functional habitats). These habitats can be expressed in terms of physical, chemical, and biological parameters. However species' biological requirements are expressed—whether in terms of population variables or habitat components—there is a strong causal link between the two: actions that affect habitat have the potential to affect population abundance, productivity, and diversity.

Ideally, reliable scientific information on a species' biological requirements would exist at both the population and the ESU levels, and the effects on habitat would be also readily quantifiable in terms of population impacts. In the absence of such information, NMFS' analysis must rely on generally-applicable scientific information that can reasonably be extrapolated to the action area and to the populations in question. Therefore, in its habitat analysis, NMFS usually defines the biological requirements in terms of properly functioning condition (PFC). PFC is the sustained presence of natural[3] habitat-forming processes that are necessary for the long-term survival of the species through the full range of environmental variation (NMFS 1999a). PFC, then, constitutes the habitat component of a species' biological requirements. The indicators of PFC vary between different landscapes based on unique physiographic and geologic features.

[3] The word "natural" in this definition is not intended to imply "pristine," nor does the best available science lead us to believe that only pristine wilderness will support salmon. The best available science does lead us to believe that the level of habitat function necessary for the long-term survival of salmon (PFC) is most reliably and efficiently recovered and maintained by simply eliminating anthropogenic impairments, and does not usually require artificial restoration (Rhodes et al., 1994; National Research Council, 1996).

In the PFC framework, baseline environmental conditions may be described as "properly functioning," "at risk," or "not properly functioning." If a proposed action would be likely to impair[4] properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC, it will usually be found likely to jeopardize the continued existence of the species or adversely modify its critical habitat or both, depending upon the specific considerations of the analysis.

NMFS does not yet have a PFC framework for estuarine habitats that could be employed as part of the effects analysis for this reinitiation of consultation. Instead, NMFS worked with FWS, the Corps, and the Ports to develop a conceptual ecosystem model that describes properly functioning riverine and estuarine processes and functions.

The conceptual ecosystem model integrates the major ecological processes that affect ecosystem structure and functions as they relate to juvenile and adult salmonids in the Lower Columbia River, and estuary. The specific objectives of the model are to: (1) Provide an ecosystem-level scientific framework for evaluating the proposed action; (2) identify links among physical, chemical and biological indicators; (3) aid in the identification of ecosystem-based processes that link salmon and the potential effects of the proposed action; and (4) develop a systematic methodology to evaluate monitoring and adaptive management opportunities. The conceptual model is described further in Chapter 5 of the 2001 BA.

The pathways and indicators of the conceptual ecosystem generally model follow the NMFS' PFC concept. Accordingly, the model serves as a useful tool to analyze effects of the Project (see Sections 6.2 - 6.7 of this Opinion). When combined with the other available modeling and scientific information, these components collectively constitute the best scientific and commercial information available to NMFS and the Corps upon which to base this consultation.

1.3.2 Evaluate the Relevance of the Environmental Baseline to the Species' Current Status

The environmental baseline represents the current set of conditions to which the effects of the proposed or continuing action are added. It includes "the past and present impacts of all Federal state or private activities in the action area, the anticipated impacts of all proposed Federal projects in the action that have already undergone formal or early section 7 consultation and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02 [1999])."

The environmental baseline does not include any future discretionary Federal activities in the action area that have not yet undergone ESA consultation in the action area. The species' current status is described in relation to the risks presented by the continuing effects of all previous actions and resource commitments that are not subject to further exercise of Federal discretion. For an ongoing Federal action, those effects of the action

[4] In this document, to "impair" habitat means to reduce habitat condition to the extent that it does not fully support long-term salmon survival, and therefore "impaired habitat" is that which does not perform that full support function. Note that "impair" and "impaired" are not intended to signify any and all reduction in habitat condition.

resulting from past unalterable resource commitments are included in the baseline, and those effects that would be caused by the continuing of the proposed action are then analyzed for determination of effects.

The reason for determining the species' status under the environmental baseline is to better understand the relative significance of the effects of the proposed action upon the species likelihood of survival and chances for recovery. Thus, if the species status is poor and the baseline is degraded at the time of consultation, it is more likely that any additional adverse effects caused by the proposed or continuing action will be significant.

1.3.3 Determine the effects of the proposed action on ESA-Listed Salmonids

In this step of the analysis, NMFS examines the likely effects of the prosed action on the species and its habitat within the context of its current status and the existing environmental baseline. The analysis considers both direct and indirect effects of the action. Direct effects are the direct or immediate effects of the project on the species or its habitat. Indirect effects are effects caused by or result from the proposed action, are later in time, and are reasonably certain to occur. This analysis also takes into account the direct and indirect effects of actions that are interrelated or interdependent with the proposed action. Interrelated actions are actions that are part of a larger action and depend on the larger action for their justification. Interdependent actions are actions that have no independent utility apart from the action under consideration.

1.3.4 Consider Cumulative Effects in the Action Area

The ESA and its implementing regulations require NMFS to take into account the cumulative effects of future (non-federal) actions on ESA-listed salmonids and their critical habitat, if designated, in the action area. The ESA implementing regulations define cumulative effects as those effects caused by future non-federal projects and activities unrelated to the action under consideration that are reasonably certain to occur within the action area (50 CFR 402.2[1999]).

1.3.5 Jeopardy Determination

In this step of the analysis, NMFS determines whether the species can be expected to survive, with an adequate potential for recovery, under the effects of the proposed action, environmental baseline and cumulative effects; and whether the action will appreciably diminish the value of critical habitat for both survival and recovery of the species. If NMFS determines that the proposed action is likely to jeopardize the continued existence of the ESA-listed salmonids or result in the destruction or adverse modification of designated critical habitat, NMFS must identify reasonable and prudent alternative(s) to the proposed action that will fulfill the purposes of the proposed action while avoiding jeopardy and adverse modification of critical habitat. If the conclusion is no-jeopardy, then NMFS must identify reasonable and prudent measures, which include implementing terms and conditions, designed to minimize incidental take of listed species, and if appropriate, conservation recommendations to further the conservation of ESA-listed species.

2. BACKGROUND

2.1 Introduction to the Columbia River Channel Improvements Project

The U.S. Army Corps of Engineers (Corps) maintains the Federal Navigation Channel in the Columbia River through operation and maintenance dredging. Currently, the navigation channel is maintained at an average depth of 40 feet in depth including advanced maintenance dredging up to 100 feet over-width and five feet over-depth.

The Columbia River Channel Improvements Project (Project) includes two distinct types of activities: Deepening of the navigation channel (includes turning basin improvements and berths that are interrelated and/or interdependent to the Project), and ecosystem restoration. Associated with the navigation channel improvements and ecosystem restoration and research activities are compliance, monitoring, and adaptive management actions.

Navigation channel improvements will require two main actions: dredging and disposal of dredged materials. Dredging and disposal will occur in two stages: an initial construction program to deepen the existing navigation channel, and a subsequent program to maintain the deepened navigation channel. The construction phase will last two years, and the maintenance phase will last the remainder of the authorized 50 year economic life of the Project (see Section 3.2 of this Opinion, Description of the Proposed Action). The Project will continue beyond 50 years unless un-authorized by Congress.

2.2 Consultation History

This consultation is the reinitiation of the previous consultation undertaken by the NMFS and the Corps on the proposed navigation channel improvements. Below is a brief synopsis of the history of the first and second phases of this process. A more complete description can be found in Section 1.3 of the 2001 BA.

<u>First Phase</u>

In its April 5, 1999, BA, the Corps requested formal consultation for the proposed Project. NMFS worked with the Corps for several months to identify further information regarding the anticipated effects of the proposed action on ESA-listed salmonids. On August 25, 1999, upon receipt of the Final Environmental Impact Statement (FEIS), NMFS determined there was sufficient information to initiate formal consultation. On December 3, 1999, the Corps amended its proposed action and BA to include additional conservation actions, including research, ecological restoration, and monitoring. On December 16, 1999, NMFS issued a biological opinion for the proposed Project. The biological opinion determined that, based on the conservation measures proposed, the Project would not jeopardize the continued existence of ESA-listed salmonids found in the action area or adversely modify their designated critical habitat.

Second Phase

On August 25, 2000, NMFS officially withdrew the December 16, 1999 biological opinion and requested reinitiation of consultation (see Appendix A of the 2001 BA for withdrawal letter). NMFS requested reinitiation of consultation to fully assess the implications of new information associated with the project impacts, to reach agreement on the specific studies and monitoring to be undertaken, to clarify the commitments and schedules for undertaking the restoration work, and to make any necessary refinements to the conservation measures associated with the proposed action. NMFS, FWS, the Corps, agreed the Corps should prepare a new BA (2001 BA) and reevaluate the Project's effects on ESA-listed salmonids.

The objective of this comprehensive reevaluation was to improve the scientific understanding of the effects of the Project and to reduce the uncertainties associated with these evaluations through the use of multiple complementary modeling efforts and independent scientific review. The reinitiation of consultation resulted in a reevaluation of ESA-listed salmonid issues by an independent, scientific panel; a series of five technical panel discussions open to the public; and a multi-agency biological review team. These efforts resulted in the development and use of new analytical tools, including two numerical models and an ecosystem-based conceptual model. During the reinitiation process, the Corps, NMFS, FWS, and the Ports participated in a mutual analysis of Project effects, and subsequently identified modifications to the Project to minimize or avoid potential Project effects.

To provide further assurances that the Project was successful in minimizing or avoiding adverse effects to ESA-listed species, NMFS and the Corps developed monitoring activities and adaptive management requirements that have been incorporated into the proposed action for the Project.

Finally, during this deliberative process, FWS and NMFS recommended ecosystem research to fulfill the Corps' responsibilities under section 7(a)(1) of the ESA. The Corps, FWS, and the Ports also identified additional ecosystem restoration features to fulfill the Corps' responsibilities under section 7(a)(1) of the ESA, which were included in the proposed action for the Project. NMFS reviewed those ecosystem restoration features during the development of the 2001 BA.

3. THE PROPOSED ACTION

3.1 Introduction

Subsequent to NMFS' August 25, 2000, withdrawal of its December 1999 biological opinion, the Corps, sponsoring Ports, NMFS, and FWS developed a "reinitiation framework" to address NMFS' major concerns and to re-define, as necessary, the proposed action. Several steps were involved in the development of the current proposed action, including a re-evaluation of potential Project effects, an analysis of these potential effects within the framework of an ecosystem-based conceptual ecosystem model, and the development of compliance measures and monitoring conditions based on the effects analyses. As part of the reinitiation process, the Corps, NMFS, FWS and the Ports identified additional monitoring, research, and adaptive management components of the proposed action. The Corps, FWS, and the Ports also identified additional ecosystem restoration features to be included in the proposed action for the Project. NMFS reviewed those ecosystem restoration features as part of the development of the 2001 BA (see Section 1.3.2). The Corps' 2001 BA fully describes this reinitiation process, and those descriptions are incorporated herein by reference. The following is a brief overview of the steps that led to the current proposed action.

To facilitate discussion of the scientific questions raised by NMFS in their August 25, 2000, withdrawal letter, the Corps, NMFS, FWS, and the Ports retained Sustainable Ecosystems Institute (SEI), a public-benefit, science mediation group. Through a panel of seven nationally-prominent technical experts, SEI provided an independent, scientific process to evaluate the potential environmental issues surrounding improvement of the navigation channel. A series of SEI workshops helped frame major concerns raised in connection with the proposed Project and identify best available science for additional analysis of Project effects.

Beginning in early spring 2001, the Corps, NMFS, FWS, and the Ports formed a technical group called the Biological Review Team (BRT). The BRT engaged in regular meetings to further review and address technical issues associated with the proposed Project and its potential effects. These BRT technical meetings occurred during and after the SEI workshops, and the results were incorporated into the SEI workshop proceedings.

During the SEI workshop process, a conceptual ecosystem model was designed to provide an integrated description of the major ecosystem links that affect ecosystem structure and function as they relate to juvenile salmonid production and ocean entry (see Chapter 5 of the 2001 BA). The specific objectives of the model were to:

- Provide an ecosystem-level scientific framework for evaluating the Project.
- Identify links among physical-chemical and biological indicators.
- Aid in the identification of ecosystem-based processes that link salmon and potential effects of the Project.
- Develop a systematic methodology to evaluate monitoring and adaptive management opportunities.

The conceptual ecosystem model describes the physical and biological interactions of the Lower Columbia River (from Bonneville Dam downstream to the upper end of the estuary at RM 40, estuary (RM 40 to Rm 3), and river mouth (RM3 to deep water disposal site)) in a manner that, when they are properly functioning, help to characterize PFC for the system. The model was used by the BRT as an analytical tool for Project effects analyses. The Corps also conducted additional numerical modeling of hydraulic parameters (i.e., salinity, velocity, depth, and temperature) for the Lower Columbia River, estuary and river mouth. Modeling analysis was conducted by both the Oregon Health and Science University/Oregon Graduate Institute (OHSU/OGI) and the Corps' Waterways Experiment Station (WES). The OHSU/OGI modeling was conducted to verify the previous conclusion of the WES modeling from the Corps'1999 FEIS and provide additional analyses on potential Project effects to habitat opportunity for juvenile salmonids (Bottom et at., 2001).

Ultimately, the Corps, NMFS, FWS, and Ports reviewed each aspect of the original 1999 proposed action, and using the best available science, including the SEI workshops, the numeric and conceptual models, and the results of the BRT meetings, agreed upon the current proposed action for dredging and disposal activities. The BRT identified additional compliance measures and monitoring conditions in order to minimize or avoid Project effects. Finally, the BRT proposed an adaptive management process to review information from the compliance and monitoring activities and make necessary Project modifications to minimize and avoid impacts.

3.2 Description of the Proposed Action

The proposed action consists of several components that have been developed over the course of this consultation. They include:

- Construction of the deeper navigation channel, employing a range of best management practices to avoid or minimize harm to ESA-listed salmonids.
- Maintenance dredging to maintain navigation depths for the navigation channel and other associated features.
- Disposal of construction and maintenance dredged materials in suitable locations to avoid or minimize adverse effects on ESA-listed salmonids and, where appropriate, improve ecological functions in the near shore area.
- Design and implementation of a robust monitoring program to evaluate implementation performance and ecological responses.
- Implementation of an adaptive management process to respond to future adverse effects.
- Implementation of ecosystem restoration efforts to improve ecological functions of significance to ESA-listed salmonids in the Lower Columbia River and estuary.
- Undertaking an ecological research program to further reduce uncertainties over the life of the Project.

Each of these elements of the proposed action are summarized below. A more complete description of them is in the 2001 BA (see Sections 3, 8, and 9) and are incorporated herein by reference.

The proposed action can be categorized into two distinct types of activities: Deepening of the navigation channel (includes turning basins and berths that are interrelated and/or interdependent to the Project); and ecosystem restoration and research. Associated with the navigation channel improvements and ecosystem restoration and research activities are compliance, monitoring, and adaptive management actions.

Navigation channel improvements will require two main actions: dredging and disposal of dredged materials. Dredging and disposal of dredged materials will occur in two stages: an initial construction program to deepen the existing navigation channel, turning basins, and berths that are interrelated and/or interdependent to the Project, and a subsequent program to maintain the deepened navigation channel, berths, and turning basins. The construction phase will last 2 years, and the maintenance phase will last the remainder of the authorized Project life. Project actions specific to dredging and disposal are described below.

Deepening of the lower Willamette River, which had been a component of the authorized Project and discussed in the 1999 FEIS, is not reasonably certain to occur. Portions of the lower Willamette River have been designated as a Federal National Priorities List site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Construction of the Project's lower Willamette River features has been deferred pending study and selection of an appropriate remedy for cleanup under CERCLA. Because the lower Willamette deepening is not reasonably certain to occur, this potential future Federal action is not addressed in this Opinion.

Construction and maintenance dredging at Lower Columbia River berths associated with three grain facilities, one gypsum plant, and one container terminal, represent actions that are interrelated and/or interdependent to the Project. Therefore, this Opinion considers the effects to ESA-listed salmonids from these berth deepening and maintenance activities. However, this Opinion does not provide incidental take coverage for berth dredging, as these activities will indergo future ESA consultation. The future ESA consultation will initiate upon NMFS' receipt of applications for Federal permits, prior to berth dredging activities.

The Corps proposes to increase the depth of the Columbia River navigation channel, from its presently authorized -40 Columbia River Datum (CRD) feet, to -43 CRD feet. "Advanced maintenance" dredging will occur during the Project's construction and maintenance components, including advanced maintenance dredging for up to 100 feet over width and 5 feet over depth for a maximum constructed navigation channel depth of 48 feet. This is a standard practice for operation and maintenance of the 40-foot channel and is used to insure a safe operational depth between operation and maintenance dredging periods. The current navigation channel's 600-foot width will be maintained, with additional channel width at channel turns and areas of high-reoccurrence of shoaling. The improved navigation channel will exist in the same location as the current -40 foot navigation channel. In addition, a total of three existing turning basins would be deepened to -43 CRD feet and maintained as part of the proposed action. Currently existing Lower Columbia River berths at three grain facilities, one gypsum plant, and one container terminal, which are interrelated and/or interdependent to the Project, will be deepened to -43 CRD feet and maintained.

The Corps proposes to deepen the navigation channel, from River Mile (RM) 3 to RM 106.5 on the Columbia River (see Section 1.2 and Figure 1-1 of the 2001 BA). An estimated total of 19 million cubic yards (mcy) of sand, 76,000 cubic yards (cy) of basalt rock, and 240,000 cy of cemented sand, gravel, and boulders would be initially removed from the navigation channel using hopper, clamshell, and pipeline dredges. Once the improvements are completed, the channel will require annual maintenance dredging. Over the initial 20 years, annual maintenance dredging is expected to decline from around 8 mcy to about 3 mcy of sand annually as the new channel reaches equilibrium. Annual maintenance will then continue at an average of about 3 mcy of sand per year for the succeeding 30-years. This amounts to a total Project dredging quantity of about 190 mcy for the Project. During this same 50 year period without the 43 foot project, approximately 160 mcy would be dredged to maintain the 40 foot channel.

The Corps is proposing to employ contractors, Federal and Port personnel, vessels, and equipment to implement the Project's dredging and disposal activities. Channel construction and maintenance will encompass a variety of dredging and dredged material disposal methods, as well as associated impact minimization measures. NMFS has reviewed each portion of the action to develop additional impact minimization and best management practices (BMPs), which the Corps has incorporated as a component of the proposed action. The following is a general discussion of the pre-project planning, dredging and disposal methods, locations, and impact minimization measures.

3.2.1 Navigation Channel Shoals that are Less than 48 Feet Deep

Construction and maintenance dredging activities will mainly focus on navigation channel shoals that are less than 48 feet deep. These channel features will be surveyed prior to construction and maintenance dredging activities, and dredging activities will be localized and limited to these shallow shoal features.

3.2.2 Construction and Maintenance Dredging

Once the planning actions are complete, the following best management practices (BMPs), including Project compliance activities, will apply to Project construction and maintenance dredging (Table 3.1). These BMPs for the dredging actions are designed to avoid or minimize potential for adverse effects upon or take of ESA-listed salmonids. Construction and maintenance dredging BMPs will remain in effect during the life of the Project, or until new information becomes available that would warrant change (see Section 3.1.6, below). Contractors or other construction and maintenance workers will employ the following methods described in Table 3.1, as appropriate, to most efficiently complete the construction and maintenance dredging activities. Contractors and other workers will be required to conduct dredging activities in compliance with the proposed action, including full implementation of BMPs, compliance monitoring, and reporting. Section 7.3 of the 2001 BA contains a more complete description of the compliance monitoring program. It is incorporated herein by reference.

Table 3.1 Dredging Methods, Descriptions, and Associated Best Management Practices

Dredging Method	Description (also refer to 2001 BA)	Best Management Practices
Hopper	Use dual dragarms to lower dragheads onto substrate. River bed materials are removed via suction to transport materials into the hold of the vessel. Generally used for small sand shoals in river and large sand shoals in estuary.	-Minimize entrainment by maintaining, to the extent possible, the draghead below substrate. Pumping must stop if dragarm is raised more than 3 feet above substrate. -Minimize turbidity by maintaining, to the extent possible, the draghead below substrate. -Contracts will specify compliance plans
Mechanical	Use bucket to remove materials and transfer to a barge for transport. Includes clamshell, dragline, and backhoe dredges. Mainly used during construction phase for removal of cemented sands, gravels, and fractured rock. Limited maintenance application, mainly in confined areas.	-Contractors will specify compliance plans -Future berth deepening and maintenance will occur within timing window of November 1-February 28
Pipeline	Use cutterhead on end of long pipe to remove sediments. River bed materials are removed via suction to a floating pipeline. The pipeline delivers the river bed materials to the disposal location.	-Minimize entrainment by maintaining, to the extent possible, the cutterhead below substrate. Pumping must stop if cutterhead is raised more than 3 feet above substrate. -Minimize turbidity by maintaining, to the extent possible, the cutterhead below substrate. -Contractors will specify compliance plans
Drilling and Blasting	Associated with channel construction at basalt rock outcrops. Holes would be drilled in underwater rock formation, and charges set to create an implosion.	-A blasting plan would be developed for each site. -Implosion rather than explosion. -Over-pressure from blast less than ten psi. -Monitoring of blasts. -Fish "hazing" employed prior to blast. -Timing window of November 1-February 28.

Project construction dredging, using any of the aforementioned dredging methodologies, may occur year-round until the navigation channel and turning basin deepening is complete. Future berth deepening will occur within a timing window of November 1-February 28. Another exception to the aforementioned in-water work window "waiver" is removal of rocks via blasting. Any rock blasting will occur within an in-water timing requirement of November 1 to February 28.

Project maintenance dredging for navigation channel or turning basin features will not have any in-water timing restrictions. However, the Corps has traditionally implemented navigation channel maintenance dredging from May through October, and anticipates Project maintenance dredging to occur during May 1 to October 31 annually. Future berth maintenance dredging will occur within a timing window of November 1-February 28.

3.2.3 Construction and Maintenance Disposal Activities

Dredged materials from Project construction and maintenance will be disposed of in upland, flowlane, shoreline, mitigation sites, ecosystem restoration sites, and one ocean disposal location. Most of the Project's dredged material would be disposed of on upland locations. All dredged materials destined for flowlane, shoreline or ocean disposal will not exceed thresholds for sediment composition and quality, as identified in the Corps' and Environmental Protection Agency's Dredged Materials Evaluation Framework (DMEF). Table 3.2 outlines the various disposal options and volumes of dredged material. Disposal options and the associated material volume for the first 20 years include: 29 upland locations covering 1,755 acres (71 mcy); ocean (16 mcy-The proposed Lois Island and Miller/Pillar ecosystem restoration actions may use dredged materails scheduled for ocean disposal, and would significantly reduce the total ocean disposal volume [L. Hicks, pers. comm.])); flowlane (23 mcy); shoreline (1 mcy); two ecosystem restoration features (15 mcy); and one mitigation site (1 mcy). Future effects analyses on the ocean deep water site will also be conducted as part of NMFS' consultation on the Mouth of the Columbia River Project.

Following the Corps' public process on the supplemental integrated feasibility report/EIS, the disposal plan will be finalized.

The following methods, and associated BMPs, will be used for dredged material disposal (Table 3.2). These BMPs, which will be included in the final disposal plan, will avoid or minimize impacts to ESA-listed salmonid species. Material disposal BMPs will remain in effect throughout the Project, or until new information becomes available that would warrant change (see Section 3.2.6 below).

Table 3.2 Disposal Methods, Descriptions, and Associated Best Management Practices

Disposal Method	Description (also refer to BA)	Best Management Practices
Upland	Materials pumped via slurry pipeline or hauled to upland site. Materials permanently held at upland site via earthen dikes. Any shoreline site associated with upland disposal will be restored.	-Upland sites bermed to maximize settling of fine materials. -New upland sites located a minimum of 300 feet from shoreline or other aquatic habitat feature. Existing sites may not have this habitat buffer, but currently provide limited habitat value. -Riparian vegetation will be protected. -Vegetative restoration will occur.
Flowlane	Either hopper or pipeline methods will use flowlane disposal. Dredged materials will be released into deep water sites within or adjacent to navigation channel.	-Maintain discharge pipe of pipeline dredge at depths greater than 20 feet. -Dispose of material in a manner that prevents in-water mounding.
Shoreline	Pipeline method primarily used for shoreline disposal. A sand and water slurry is pumped onto an existing beach or shoreline landing, and the beach is extended approximately 100-150 feet into and for varying distances along the river channel. Shoreline disposal occurs concurrently with dredging; timing restrictions therefore based on dredging methodology.	-Contour new beach to minimum steepness of 10-15% slope, to prevent fish stranding. -Only highly-erosive, and therefore lower habitat quality, shoreline sites will be used.
Ocean	A single, 200-300 foot deep ocean location, approximately 4.5 miles west of the Columbia River mouth, will be used for ocean disposal. Hopper dredges will release dredged materials in an 11,000 by 17,000 foot area.	-No ESA BMPs. -Dispose of material in accordance with the site monitoring and management plan which calls for a point dump placement of material from the project during construction. The plan is to place any construction material in the southwest corner of the deep water ocean site.
In-water fill	In-water fills will be used to create intertidal marsh and flats, shallow sub-tidal habitat at Miller Pillar, Lois Island Embayment and the Martin Island mitigation site.	Historic elevations for tidal marsh and flats and shallow subtidal habitats at these locations will be constructed using clean dredged material.

Project disposal activities will not have any in-water timing restrictions. However, as disposal occurs at the same time as dredging activities, dredged material disposal associated with construction dredging will occur year round, whereas disposal associated with maintenance dredging most likely will occur from May through October.

3.2.4 Additional Provisions for Protection of Water Resources

Additional provisions regarding release of trash, garbage, hazardous waste, or other contaminants will be implemented during dredging and disposal activities (Table 3.3).

Table 3.3 Additional Provisions for Protection of Water Resources

General Measure	Action
The contractor shall not release any trash, garbage, oil, grease, chemicals, or other contaminants into the waterway.	-If material is released, it shall be immediately removed and the area restored to a condition approximating the adjacent undisturbed area. -Contaminated ground shall be excavated and removed and the area restored as directed. -Any in-water release shall be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.
The contractor, where possible, will use or propose for use, materials that may be considered environmentally-friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal of this material shall be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	-If material is released, it shall be immediately removed and the area restored to a condition approximating the adjacent undisturbed area. -Contaminated ground shall be excavated and removed and the area restored as directed. -Any in-water release shall be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.

3.2.5 Locations for Construction and Maintenance Dredging and Dredged Material Disposal

Construction and maintenance dredging and dredged material disposal locations are identified by river reach in the following table (Table 3.4). Dredged material removed from a reach of the river could be disposed in a location in a different reach of the river. The table is only intended to display the dredging location and disposal location within a given reach, not to imply material movement from one location to another. Unrestrained open water (flow lane) disposal of suitable dredged materials may occur anywhere in or immediately adjacent to the navigation channel, and at any time in the Project area, RM 3-106.5.

Table 3.4 Proposed Dredging Locations, Disposal Locations, and Types of Disposal

River Reach	Dredge Locations	Disposal Locations, Type (U=upland, F=flowlane, S=shoreline, I=in-water)
Reach 1 RM 98-106.5	Lower Vancouver Bar (RM 101.3-104.6) Morgan Bar (RM 97.8-101.3) Vancouver Turning Basin (RM 105.5) Terminal 6 Berths (3 berths) (RM 100-101) United Harvest Berth (RM 105.2)	West Hayden Island (RM 105.0) **U** Gateway 3 (RM 101.0) **U** Entire Reach **F**
Reach 2 RM 84-98	Willow Bar (RM 93-9-97.8) Henrici Bar (RM 90.4-94.9) Warrior Rock Bar (RM 87.3-90.4) St. Helens Bar (RM 83.3-87.3)	Fazio Sand & Gravel (RM 96.9) **U** Adjacent Fazio (RM 96.9) **U** Lonestar (RM 91.5) **U** Railroad Corridor (RM 87.8) **U** Austin Point (RM 86.5) **U** Sand Island (RM 86.2) **S** Entire Reach **F**
Reach 3 RM 70-84	Upper Martin Island Bar (RM 80.3-83.8) Lower Martin Island Bar (RM 76.5-80.3) Kalama Ranges (RM 72.8-76.5) Upper Dobelbower Bar (RM 69.9-72.8) Kalama Export Grain Berth (RM 77.1) Port-of-Kalama Berth (RM 73.4) Kalama Turning Basin (RM 73.5)	Reichold (RM 82.6) **U** Martin Bar (RM 82.0) **U** Martin Island Lagoon (RM 80) **I** Lower Deer Island (RM 77.0) **U** Sandy Island (RM 75.8) **U** Northport (RM 71.9) **U** Cottonwood Island (RM 70.1) **U** Entire Reach **F**
Reach 4 RM 56-70	Lower Dobelbower Bar (RM 67.1-69.9) Slaughters Bar (RM 63.2-67.1) Walker Island Reach (RM 59.4-63.2) Stella-Fisher Bar (RM 55.6-59.4) U.S. Gypsum Berth (RM 65.7)	Howard Island (RM 68.7) **U** International (RM 67.5) **U** Rainier Beach (RM 67.0) **U** Rainier Industrial (RM 64.8) **U** Lord Island (RM 63.5) **U** Reynolds Aluminum (RM 63.5) **U** Mt. Solo (RM 63.5) **U** Hump Island (RM 59.7) **U** Crims Island (RM 57.0) **U** Entire Reach **F**
Reach 5 RM 40-56	Gull Island Bar (RM 51.9-55.6) Eureka Bar (RM 48.2-51.9) Westport Bar (RM 44.5-48.2) Wauna and Driscoll Ranges (RM 40.8-44.5)	Port Westward (RM 54.0) **U** Brown Island (RM 46.3) **U** Puget Island (RM 44.0) **U** James River (RM 42.9) **U** Entire Reach **F**
Reach 6 RM 29-40	Puget Island Bar (RM 36.6-40.8) Skamokawa Bar (RM 32.6-36.6) Brookfield-Welch Island Bar (RM 28.8-32.6)	Tenasillahe Island (RM 38.3) **U** Welch Island (RM 34.0) **U** Skamokawa (RM 33.4) **S** Entire Reach **F**

River Reach	Dredge Locations	Disposal Locations, Type (U=upland, F=flowlane, S=shoreline, I=in-water)
Reach 7 RM 3-29	Pillar Rock Ranges (RM 25.2-28.8) Miller Sands Channel (RM 21.4-25.2) Tongue Point Crossing (RM 17.5-21.4) Upper Sands (RM 13.6-17.5) Flavel Bar (RM 10.0-13.6) Upper Desdemona Shoal (RM 4.4-10.0) Lower Desdemona Shoal (RM 3.0-4.4) Astoria Turning Basin (RM 13)	Pillar Rock Island (RM 27.2) **U** Miller Sands (RM 23.5) **S** Rice Island (RM 21.0) **U** Entire Reach **F**
River Mouth RM 3-ocean	None	"Point dump" placement within southwest corner of deep water ocean site

3.2.6 Monitoring Program and Adaptive Management Process

As part of the Project, the Corps will implement a monitoring program. Monitoring actions were identified during the BRT's review and analysis of Project-related, short- and long-term, direct and indirect effects; discussions of relative risk of Project effects; and the certainty surrounding data used to determine risk. These monitoring activities will generate information and evaluate predicted effects to ESA-listed salmonids, validate assumptions used in the 2001 BA's effects analysis, and reduce overall risk and uncertainty associated with implementation of the Project's actions.

Table 3.5 provides a brief overview of the proposed monitoring program. The entire description of the monitoring program included in Chapter 7, Table 7-3 of the 2001 BA, is incorporated by reference into this Opinion. Compliance monitoring will also occur during dredging and disposal activities for both construction and maintenance periods. Compliance monitoring was previously described in Construction and Maintenance Dredging Section, above.

Table 3.5 Key Components of Monitoring Program

Monitoring Task	NMFS and FWS' Concerns	Data Analysis	Duration	Management Trigger Points
Maintain three hydraulic monitoring stations: One downstream of Astoria, one in Grays Bay, and one in Cathlamet Bay. Parameters measured would include salinity, water surface elevation, and water temperature.	Long-term physical parameter changes related to Project.	An analysis would be conducted to determine pre- and post-project relationships among flow, tide, salinity, water surface, and temperature.	7 years: 2 years before, 2 years during, and 3 years after construction.	Post-project monitoring data exceeds defined threshold values (to be developed by adaptive management team).
Monitor annual dredging volumes; both from construction and O&M activities.	Dredging volumes may be larger than predicted.	Actual volumes will be compared to predicted.	Life of the project.	Actual dredging volumes exceed capacity of the disposal plan.
Conduct main channel bathymetric surveys throughout Project area.	Side-slope adjustments may occur in other locations, and within sensitive aquatic habitats, than predicted.	Bathymetric changes will be tracked to determine if habitat is altered.	7 years: 2 years before, 2 years during, and 3 years after construction	Salmonid habitat alteration adjacent to navigation channel due to side-slope adjustment.
Repeat estuary habitat surveys being conducted by NMFS.	Long-term macro- and micro-habitat changes related to Project	Habitat mapping from aerial photos and ground surveys.	One time survey conducted 3 years after completion of the deepening.	Changes to individual habitat types that are based on defined threshold values. Determine need for other surveys.

Monitoring Task	NMFS and FWS' Concerns	Data Analysis	Duration	Management Trigger Points
The Corps, NMFS, and Service will meet annually, or as new circumstances arise, to review new sediment chemistry data from the Lower Columbia River and estuary. If these data exceed DMEF or NMFS contaminants guidelines for salmonid protection, or if other events such as changes in guidelines or threshold values occur, additional sediment and contaminant sampling would be initiated in accordance with the DMEF manual	Ensure that channel construction and maintenance does not disturb undetected deposits of fine-grained material, potentially causing redistribution of contaminants that could pose a risk to salmon and trout.	New Corps sediment data, collected in response to the annual MA-5 monitoring action, will be reviewed in accordance with the DMEF manual and will be compared to the NMFS contaminants guidelines for the protection of salmon and trout.	Two years before construction, two years during construction, and annually during maintenance activities.	Any exceedance of NMFS or DMEF guidelines will be reported to the adaptive management team to determine if consultation should be reinitiated.
Monitor the incidence of stranding of juvenile salmon on beaches in action area. Field surveys will be made monthly at selected beaches (upper, mid, and lower river) during the April-August out-migration to measure the number of fish being stranded along beaches.	Concern that disposal sites and ship traffic may allow for juvenile salmonid stranding.	Compare pre- and post-project stranding counts.	One year before deepening and 1 year after deepening.	If there is an increase in the number of fish stranded, proposals would be developed and presented to adaptive management team.

An essential component of the monitoring program as described in Table 3.5 is the ongoing sampling of bottom sediments and testing for contaminants. For this Project, the Corps will use the 1998 regional Dredged Material Evaluation Framework (DMEF) protocols governing testing and evaluation of sediment to be dredged. The DMEF establishes minimum guidelines for testing and evaluation. The DMEF guidelines require the use of available sediment and contaminants information to make a preliminary determination concerning the need for testing of material proposed for dredging. Where available information suggests additional testing is required, sediments will be collected and analyzed prior to dredging and disposal. Otherwise, DMEF minimum sampling guidelines require periodic testing of sediments for long-term activities.

The Corps' analysis of available Lower Columbia River and estuary information revealed few samples with fine materials and no samples with contaminant concentrations that exceed the regional DMEF guidelines or NMFS sediment contaminant guidelines that are protective of listed salmon and trout. The Corps will test channel sediments in accordance with the DMEF guidelines, at a minimum of every 10 years in the main channel for sandy areas, every seven years for fine grained areas with no history of contamination at all, and every seven years where there is reason to believe contaminants may be present (Table 3.6). As noted in the 2001 BA

Table 7-3, Monitoring Action MA 5, all information collected during these sediment and contaminant reviews, as well as sediment data from other sources, will be reported to the adaptive management team.

Table 3.6 Sediment Testing Locations and Minimum Frequency for New Sediment Sampling

Dredging Location	Frequency of Sampling (Yrs)
Main Channel RM 3-106.5	10
Turning Basins	
Astoria Turning Basin (RM 13)	7
Kalama Turning Basin (RM 73.5)	10
Vancouver Turning Basin (RM 105.5)	10
Berths	
United Harvest at Port of Vancouver (RM 104.2)	10
Harvest States at Port of Kalama (RM 77.1)	10
Peavy Grain at Port of Kalama (RM 73.4)	10
Terminal 6 at Port of Portland	7
U.S. Gypsum at Port of Rainier (RM 65.3)	10

The Corps also proposed an Adaptive Management Process. The 2001 BA (Section 9.4) indicates: "Actions associated with dredging and disposal, and ecosystem restoration and research will be coordinated through the adaptive management process to ensure that the Project will not jeopardize listed or proposed species or destroy or adversely modify their critical habitat". The proposed adaptive management process involves review and management response to two types of Project monitoring data: Constant monitoring of Project effects during construction and maintenance activities (compliance monitoring), and annual review of monitoring data or other new information. In addition to annual reviews, any adverse finding from compliance monitoring would be addressed immediately by the adaptive management team. The proposed adaptive management review and response will ensure unanticipated Project effects are rapidly identified and effectively addressed. Finally, adaptive management will be used to evaluate whether the Project's environmental protection objectives are being met, and to ensure construction and/or maintenance actions are adjusted accordingly.

The Corps' proposed adaptive management process requires the establishment of an identified scope including goals, milestones for completion, check-in points, triggers for management changes (i.e., management decision points that include specific metrics), and sampling/testing protocols. The Corps will work with the Services to refine and develop the scope of the adaptive management process. However, the following specific adaptive management actions are identified in the 2001 BA (Section 9.0):

- An adaptive management team, comprised of representatives from NMFS, Service, Corps, and sponsor Ports, will annually review results of Project compliance measures, monitoring, research, and restoration actions. On an annual basis the adaptive management team will determine:

- if the Project is in compliance with the Service's opinions;
- if adverse Project effects have been found; and
- if any modification to the Project's compliance, monitoring, research, and restoration actions are warranted.

- If an unanticipated effect is identified, the adaptive management team will determine whether: (1) the Project should continue; (2) construction or maintenance should be altered; (3) additional ecosystem restoration should be completed; (4) construction or maintenance should be stopped until more data is collected; or (5) the construction activities should be halted.

The Corps will be responsible for implementing the adaptive management team decisions regarding adverse Project effects. Annual reviews by the adaptive management team will occur for the duration of monitoring actions proposed in the 2001 BA. The adaptive management team shall make all monitoring and research data available for public review.

3.2.7 Ecosystem Restoration and Research Actions

The Corps has incorporated ecosystem restoration and research actions into the proposed action to assist with the recovery of ESA-listed salmonid habitats, and to further the understanding of ecosystem functions and processes. These actions are not proposed to directly mitigate or compensate for any Project-related impacts to ESA-listed salmonids. The research and restoration components of the overall ecosystem restoration and research action are proposed as Conservation Measures under section 7(a)(1) of the ESA and have been included into the proposed action by the Corps. These actions are the Corps' commitment to fulfill their affirmative responsibility to assist with conservation and recovery of ESA-listed salmonids. These actions include those ecosystem restoration actions previously authorized under Section 101(b)(13) of the Water Resource Development Act of 1999, and additional ecosystem restoration actions developed during the reinitiation of consultation.

3.2.7.1 Ecosystem Restoration Activities

The Corps has proposed a total of 10 ecosystem restoration actions (Table 3.7). These projects are designed to create or improve salmonid habitat, specifically tidal marsh, swamp, and shallow water and flats habitat, and to improve fish access to these habitat features. In addition, one of the ecosystem restoration actions would restore habitat and reintroduce Columbian white-tailed deer onto Cottonwood/Howard islands. The 2001 BA (see Chapter 8 of this Opinion) provides a detailed description of these restoration activities. Those descriptions are incorporated herein by reference. All ecosystem restoration activities, except for the long-term Tenasillahe Island restoration feature, will be initiated during the Project construction period.

Table 3.7 Proposed Ecosystem Restoration Activities

Action	Purpose	Protective Measures	Monitoring
Lois Island Embayment Habitat Restoration	Restoration of 389 acres of estuarine, intertidal marsh habitat and shallow subtidal flats habitats	-Use of deep water sediment storage location (location to be determined) without in-water work window -In-water work window for material placement at Lois Island restoration feature	Post-construction benthic productivity and fish species composition and density on restoration and adjacent control sites
Purple Loosestrife Control Program	Implement an Integrated Pest Management Plan for purple loosestrife in the estuary, RM 18-52	-Only an EPA-approved over-water herbicide will be used -Strict hand application measures will prevent any herbicide from entering the water	Annual and final reports describing results of control efforts
Miller/Pillar Habitat Restoration	Re-establish 170 acres of shallow water and flats habitats	-Place dredged materials in a fashion to minimize fish and prey smothering -Bird excluders placed on pile dikes	Post-construction benthic productivity and fish species composition and density on restoration and adjacent control sites
Tenasillahe Island Interim Restoration (Tidegate and Inlet Improvements)	Improve fish passage and water circulation between sloughs and the river	-Contingent upon hydraulic analysis that ensure new features will protect Columbian white-tailed deer -August-September in-water work window	Post-construction benthic productivity and fish species composition and density on restoration and adjacent control sites, annual reporting
Tenasillahe Island Long-Term Restorations (Dike Breach)	Long-term restoration of historical habitat features, including	-Upon Columbian white-tailed deer delisting -Must be compatible with Refuge purposes and goals -No protective measures proposed	Post-construction benthic productivity and fish species composition and density on restoration and adjacent control sites, annual reporting
Cottonwood/Howard Island Proposal Columbian White-tailed Deer Introduction	Secure habitat and reintroduce Columbian white-tailed deer	-None proposed	Monitoring to assess success of translocation, and annual reports
Bachelor Slough Enhancement	Restore aquatic and riparian habitat resources	-Inwater dredging window -Dredge and disposal plan to be developed -Sediment chemistry test to be conducted	Monitor fish use of Bachelor Slough for 5 years, and annual and final reports

Action	Purpose	Protective Measures	Monitoring
Shillapoo Lake Restoration	Creation of interior wetland cells for waterfowl and other wildlife species	None proposed	None proposed
Columbia River Tidegate Retrofits	Improve fish passage at Columbia River and tributary tidegates	-Late summer installation -Short duration construction events -Coffer dams installed if culvert is replaced	None proposed
Walker-Lord and Hump-Fisher Islands Improved Embayment Circulation	Dredge connecting channels between islands to increase water circulation	-Late summer installation -Minimal turbidity anticipated	None proposed
Martin Island Embayment[5]	Development of 32 acres of tidal marsh habitat.	-Utilize sand as fill material to minimize Project-related turbidity -Contain all turbidity within project area	None proposed

3.2.7.2 Ecosystem Research Activities

Ecosystem research actions are conservation measures proposed by the Corps as part of the proposed action to assist the efforts of the Corps, NMFS, FWS, and others in the broader understanding the of Lower Columbia River ecosystem, and to assist with the recovery of ESA-listed salmonids (Table 3.8). The 2001 BA (see Chapter 8, Table 8-1) provides a tabular description of these research actions, and is incorporated herein by reference. These research actions were negotiated and designed by the BRT to provide useful information to the recovery of the ESA-listed salmonids. The proposed research activities also address specific ecosystem conceptual model indicators that are believed to be improperly functioning.

[5]The Martin Island embayment feature is a mitigation requirement from the 1999 FEIS. This action was designed to mitigate for upland disposal impacts. The Corps has requested consultation on this action, as construction of this beneficial feature could have impacts to ESA-listed salmonids

Table 3.8 Proposed Ecosystem Research Actions

Research Task	Justification	Duration	Data Analysis
Add two additional transects in different habitat types similar to those being done for the NMFS studies currently under way with annual fish evaluation process.	Provide additional habitat and salmonid distribution information for the estuary. Useful in establishing inventory information for future monitoring or restoration.	Begin before construction and for 3 years after completion of the Project.	Record value and use of different habitat types for juvenile salmonids and cutthroat trout.
Evaluate cutthroat trout use of the estuary and river areas.	Little is known about the species use of this habitat. Research to provide additional information regarding salmonids use of this habitat.	Conduct study for 2 years before construction and 2 years during construction.	Record value and use of different habitat types for juvenile salmonids and cutthroat trout.
Conduct bank-to-bank hydrographic surveys of the estuary.	Has not been done in 20 years and is needed to assess available habitat and restoration actions.	Once, prior to construction.	Bathymetry will be available for shallow water areas in the estuary.
In conjunction with ongoing studies of juvenile salmonids habitat utilization in the Lower Columbia River, collect and analyze juvenile salmonids and their prey for concentrations of chemical contaminants.	Provide additional data on contaminants in listed salmonids and their prey. Useful in establishing inventory information for future monitoring or restoration.	Begin before construction and for 3 years after construction, depending on the results.	Record concentrations of persistent contaminants (e.g., DDTs, PCBs, PAHs, dioxin-like compounds) in juvenile salmonids and prey.
In conjunction with above contaminant study, assess sublethal effects of contaminants (e.g., growth, disease resistant) on salmonids.	Provide additional data for established contaminants thresholds effect levels to ensure that guidelines are Protective of salmonids; to better characterize performance of juvenile salmonids in the estuary.	Begin before construction and for 3 years after construction, depending on the results.	Record health status of juvenile salmonids Collected above.
Estuarine Turbidity Maximum (ETM) workshop.	To further the knowledge of the ETM and the listed stocks.	Once.	Not Required.

4. BIOLOGICAL INFORMATION

4.1 General Status of ESA-Listed Salmonids

NMFS has determined that the proposed action has the potential to adversely affect ESA-listed salmonids. Based on migratory timing, ESA-listed salmonids will be present in the action area during Project construction and operation and maintenance of the 43-foot channel. A general discussion of species status can be found in the December, 2001, FCRPS biological opinion, Chapter 4.0, Biological Information; Section 4, Life Histories, Factors for Decline, and Current Rangewide Status.

4.2 Biological Requirements of Salmonids as Defined by the Conceptual Ecosystem Model

The Lower Columbia River, estuary and river mouth play a critical role in the survival and recovery of ESA-listed salmonids by providing refugia, nutrients, and conditions in which juvenile salmon undergo the physiological change from fresh-water to saltwater. NMFS' recently developed Cumulative Risk Initiative (CRI) modeling supports this conclusion. The CRI estimates population growth rates and uses this measure to assess the risk of extinction or of species decrease in abundance. The CRI analysis suggests that significant opportunities exist for securing additional improvements in overall population trends of ESA-listed salmonid stocks by reducing the substantial mortality in the estuarine and early ocean life stages (Kareiva et al., 2000).

In discussions of the importance and complex nature of the Lower Columbia River, estuary and river mouth to salmonids, the SEI panel identified the need for a consistent framework for understanding this ecosystem. The BRT worked with the SEI panel to develop a conceptual ecosystem model of the Lower Columbia River, estuary and river mouth ecosystem relationships that are significant for ESA-listed salmonids. The conceptual ecosystem model describes the physical and biological interactions of the Lower Columbia River and estuary in a manner that characterizes properly functioning habitat conditions for the system. The 2001 BA (see Chapter 5 and Appendix E) provides an extensive presentation and discussion of the conceptual ecosystem model, and describes the historic and current conditions of the Lower Columbia River, estuary, and river mouth using the model. These descriptions are incorporated herein by reference.

In NMFS' 1999 biological opinion for this Project, we determined that the biological requirements NMFS considered to be most relevant to ESA-listed and salmonids were: (1) Habitat characteristics in the Lower Columbia River and estuary ecosystems that function to support successful migration, smoltification, and rearing; and (2) water quality that supports survival and recovery of ESA-listed salmonids. For the purposes of this reinitiation analysis, these biological requirements for ESA proposed and listed salmonids have been included into the conceptual ecosystem model developed for the Project.

The following is a summary, based on the conceptual ecosystem model, of the Lower Columbia River, estuary and river mouth's ecosystem components, and how these factors collectively influence the growth and survival of the salmonid species rearing in and migrating through the Columbia River and estuary. Table 2-1 of the

2001 BA, Conceptual Model Pathways and Indicators for Juvenile Salmonid Production in the Lower Columbia River, is incorporated by reference.

4.2.1 Habitat Forming Processes

Habitats are formed primarily by the interaction of hydrodynamic forces and sediment supply. In the Lower Columbia River, estuary and river mouth, both the river and the ocean influence the riverine and estuarine hydrodynamics. Ocean processes, including tidal action and waves, interact with river processes, including currents and sediment transport, in the Lower Columbia River, estuary and river mouth to produce complex hydrodynamics. The net result is deposition (accretion) of suspended sediments to form flats and carving (erosion) to form shallow and deep channels. These habitats may be colonized by marsh and swamp vegetation, as controlled by bathymetry (elevation of substrate) and, in the estuary, salinity. Because plants and animals are adapted to certain salinity ranges, the salinity level, as well as seasonal and spatial patterns, strongly influences where species occur in the Lower Columbia River and estuary. If the turbidity levels are low enough to allow sufficient light penetration for plant growth, certain areas may develop submerged vegetation such as eelgrass. Woody debris, deposited on the flats, along channel edges, and in marshes and swamps, creates a complex, vertical structure. Habitats in deeper riverine and estuarine areas are formed by bedload transport, which shapes portions of the river and estuary bed into a series of sand waves. All of these dynamics and interactions culminate in the expression of habitat types important to salmon in the Lower Columbia River and estuary.

4.2.2 Habitat Types

The basic riverine and estuarine habitat-forming processes—physical forces of the ocean and river—create the conditions that define habitats. Key habitats types (i.e., tidal marsh and swamp, shallow water and flats, and water column), in turn, provide an opportunity for the primary plant production that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival and, ultimately, the production and ocean entry of juvenile salmonids moving through the Lower Columbia River and estuary.

The Lower Columbia River and estuary extends the freshwater habitat of salmon and expands habitat available for rearing (Wissmar and Simenstad, 1998). The estuary serves as a conduit to the ocean, transporting fish from the river to the ocean, and provides critical adult holding, spawning, incubation, juvenile rearing habitat and migration corridors for ESA-listed adult salmonids. Estuary conditions have an important effect on salmon survival (Emmett and Schiewe, 1997; Hinrichsen et al., 1997), and on the number of salmon that can be supported in the Columbia River system.

Structural and biological features of estuarine habitats that provide refugia from predators and off-channel areas protected from strong tidal and river currents are important to salmon survival. Important features that can minimize effects of predators and strong flows include: Complex dendritic tidal channel systems and other landforms (islands, peninsulas, etc.); wood, emergent vegetation, or other structural components; and connections between mainstem channels and floodplains. Availability of refugia under variable tidal and river flow levels is necessary to support diverse rearing and migratory behaviors and thereby spread the physical and biological risks to salmon through time and space.

Persistence and resilience of Pacific salmon are linked to the quantity and quality of habitats throughout the range of their life history, from freshwater spawning to oceanic rearing environments. But salmonid ecosystems are not static; freshwater, estuarine and ocean conditions vary over many time scales, but seldom in synchrony. To compensate for such uncertainty, salmon have evolved a diversity of life-history traits that allows them to function in a variable environment (Wissmar and Simenstad, 1998; Bottom et al., 2001).

The quality and diversity of estuarine rearing habitats are important factors influencing the diversity of salmon life-history types that enter a variable ocean environment. For example, salmon populations within and among species enter the Columbia River estuary at different times, reside for varying periods, and select different habitats in time and space. This variety of rearing strategies minimizes the risk of brood failure, since not all individuals behave identically under the same set of environmental conditions. Slightly different patterns of migration and rearing in the estuary are advantageous in different years depending, for example, on the timing of flood events, the onset of the spring transition, the distribution of coastal upwelling, the timing of prey production, and the distribution of predators.

Continued survival of juvenile salmon in the ocean is often dependent on prior growth in the estuary, which is largely supported by detrital food chains and prey species from a variety of estuarine habitats. Important rearing habitats for juvenile salmon include those that produce, retain, and concentrate macrodetritus in the high-flow environment of the Columbia River estuary. Among areas of production and accumulation of organic matter are dendritic tidal channels and backwater sloughs, estuarine and tidal-freshwater marshes and swamps, vegetated riparian habitats, mud and sandflats of shallow peripheral bays, and the microdetrital producing estuarine turbidity maximum zone in the mainstem channels.

The habitats most directly linked to salmonids in the Lower Columbia River and estuary include the tidal marshes and swamps, shallow water and flats, and the water column. The position and extent these habitats that allow juvenile salmon gradually to adapt to saltwater are particularly important to their performance and survival.

Tidal marshes and swamps generally occur between Mean Higher High Water (MHHW) and the Mean Lower Low Water (MLLW). Tidal marshes begin at lower tidal elevations, slightly above MLLW, and swamps occur at or above MHHW. Juvenile salmonids use the edges of these marshes to feed, and the edges of shallow channels within the marshes as refugia and feeding areas. Tidal marshes can be divided into saltwater marshes and freshwater marshes, each characterized by a distinctive vegetation type.

Tidal marshes include tidally-influenced areas all the way up to Bonneville Dam, as well as extensive tidal freshwater marshes in the Lower Columbia River, particularly those in Cathlamet Bay. Availability of feeding habitats and refugia within the oligohaline or brackish zones of the estuary constitute a critical transition area for smaller salmon juveniles when they first enter saline waters. The proper function of habitats in this area and their linkage to adjacent habitats require that salmon can move freely upstream and downstream as needed to adjust their distribution with changes in the salinity gradient.

Shallow water and flats occur throughout the intertidal zone and into the shallow subtidal zone in waters up to six feet deep. Benthic algae (largely benthic diatoms) develop on tidal flats and in the shallow subtidal zone within the system. Juvenile salmonids use shallow water and flats habitats for feeding and movement.

Water column habitat refers to waters that are greater than six feet deep. Freshwater plankton dominate the fresh and oligohaline portions of the water column upstream, and plankton tolerant of greater salinity dominate the estuary and the river mouth of water column habitats. Juvenile salmonids utilize water column habitat for feeding and movement.

4.2.2.1 Habitat Primary Productivity Pathway

A major function of the habitats is to produce food used by organisms in the ecosystem. Habitat primary productivity refers to the amount of material (biomass) produced over time during plant growth that occurs within each habitat type. Primary productivity is driven by light and is supported by inorganic nutrients (e.g., nitrate, phosphate). Inorganic nutrients enter the system from the upstream watershed and the downstream ocean currents and through the breakdown and recycling of organic matter within the system. Live plant material and detritus are the primary sources of organic matter in the food web used by salmonids in the Lower Columbia River, estuary and river mouth.

Primary productivity within water column habitat results from imported and resident phytoplankton. Imported phytoplankton are freshwater species produced in large quantities in the upstream watershed (particularly in the reservoirs behind the mainstem Columbia River and tributary dams), whereas resident phytoplankton are produced within the Lower Columbia River and estuary.

Primary productivity within the shallow water and flats habitat results mostly from benthic algae. Shallow water habitats can also produce filamentous algae and flowering grasses such as eelgrass, however, the majority of primary productivity within the river's shallow water areas comes from benthic algae.

Primary productivity within tidal marsh and swamp habitat comes from the marsh and swamp vegetation, which includes emergent plants, shrubs, and trees.

4.2.2.2 Food Web Pathway

The base of any food web is the plant material produced over time or the primary productivity within each habitat type. The food web described in the conceptual model includes macrodetritus, the large, complex forms of dead plants, primarily from tidal marsh plants. Macrodetrital webs are supported by tidal channels and backwater sloughs, marshes and swamps, vegetated riparian habitats, and other shallow water and low velocity habitats. This food web also includes microdetritus, the material from simple-celled plant or organic particles. Microdetritus can be in the form of imported microdetritus if they are derived from imported phytoplankton, or resident microdetritus if they are derived from resident phytoplankton. Small animals that shred the larger plant matter and microbes, including bacteria, protozoa, and fungi, facilitate the breakdown of detritus. In addition to making the organic matter useful to the food web, these breakdown processes recycle inorganic nutrients needed by the plants for primary production.

Fish and invertebrate community surveys in the Lower Columbia River and estuary provide strong evidence that physical processes that concentrate organic matter and maintain zooplankton populations in the estuary control the feeding environment for estuarine fishes (Bottom and Jones, 1990). Salmonids eat invertebrate prey species that are supported by resident and imported microdetritus, and macrodetritus from tidal marsh and swamp plant material. The relative amount of food and food energy depends on the abundance of each habitat type (e.g., tidal marshes) and the input of nonresident material from upstream sources. Several types of invertebrate prey species make up the next level up the food chain from the primary producers and their detritus.

Mobile macroinvertebrates are large epibenthic organisms, such as sand shrimp, mysids, and Dungeness crab, that reside on the river bottom and feed on bottom sediments and byproducts of primary productivity. Mysids are the primary macroinvertebrates that are relevant to the salmonid food web. Floating insects (larvae and adults) also appear to be important in the diet of most of the salmonid species and age classes in the salmonid food web. Many of these insect types feed on live tidal marsh plants.

Deposit feeders are benthic animals that feed by consuming organic matter in sediments. The term deposit feeders refers to both surface and subsurface deposit feeders, which include marine annelids (polychaetes), and freshwater annelids (oligochaetes), and benthic crustaceans. Suspension feeders are organisms that feed from the water column itself. For zooplankton and benthic/epibenthic organisms, this is accomplished primarily through "filter feeding" (extracting organic matter from the water column by pumping or siphoning the water through their systems). Among the most abundant species found in the stomachs of salmonids is the planktonic cladocera suspension feeder *Daphnia pulex*.

Suspension/deposit feeders are benthic and epibenthic organisms that feed on or at the interface between the sediment and the water column. Because of the shift in the Lower Columbia River to more of a "microdetrital" food web (see discussion below), the suspension/deposit feeder *Corophium salmonisis* now perhaps the most abundant species found in the stomachs of salmonids. However, nutritionally, *Corophium* may not be as desirable as other food sources for young salmon. According to Higgs, et al. (1995), gammarid amphipods such as *Corophium* are high in chitin and ash and low in available protein and energy relative to daphnids and chironomid larvae.

Thus, there has been a shift in the food web within the Lower Columbia River. Tidal marsh and swamp vegetation and macrodetritus have declined. The benthic/epibenthic food web, which was a prominent feature of the historical Lower Columbia River ecosystem, no longer produces as varied or rich a food web

(Sherwood, et al., 1990). The current ecosystem is now more dependent on a “microdetrital” food web supported by the Estuarine Turbidity Maximum (ETM) zone in the mainstem channels.

The ETM results from the combination of two processes, strong tidal forces and its interaction with the salt wedge in the Lower Columbia River. This combination results in elevated levels of suspended particulate matter. The physical process occurs when strong tidal forces push salinity upriver beneath the outflowing river water. The turbulence caused by this tidal forcing results in resuspension of sediment and other particulate material present on the river bed. Concurrently, dissolved material in the river water flocculates when it comes into contact with the salt wedge pushing its way up river. The interaction of these forces results in the ETM.

The ETM supports the detrital food chain and salmon production, and in the current estuary the ETM sustains the highest secondary productivity (Simenstad et al., 1990). Fish and invertebrate community surveys in the Columbia River estuary provide strong evidence that physical processes that promote concentration of organic matter and the maintenance of zooplankton populations within the estuary control the feeding environment for estuarine fishes (Bottom and Jones, 1990). With the degradation of the macrodetrital food chain, the ETM has assumed an important role in providing food for salmon that enables them to mature properly and enhances their ability to survive.

4.2.2.3 Growth Pathway

Salmonids are adapted for using a complex mosaic of many habitat areas as they migrate downstream, and during their residence in the Lower Columbia River, estuary and river mouth. This mosaic of habitats used by salmonids is referred to as habitat complexity. An absence or reduction in the natural complexity of habitats available may affect the salmonids’ ability to reach food resources needed for growth. Habitat conveyance is the opportunity for salmonids to move over flats and into tidal marsh systems as the water level rises and falls with the tide and with river flow. Connectivity refers to links and spatial arrangements among habitats in the mosaic of changing habitat areas. Feeding habitat opportunity reflects the variable access among feeding, rearing, and refuge habitats along the migratory corridor. Habitat-specific food availability needs to exist for salmonids to feed within the set of habitats. Lastly, low current velocity, shallow water areas provide productive feeding areas for salmonids. However, because salmonids are visual predators, turbidity and uneven bathymetry may influence their ability to successfully capture prey items.

4.2.2.4 Survival Pathway

Besides growth, a variety of factors interact to affect the ultimate survival of salmonids in the Lower Columbia River, estuary and river mouth. Factors that can negatively affect survival include contaminants, predation, suspended solids, temperature and salinity extremes, stranding, entrainment, and competition.

Contaminants may affect the health (physiological integrity) of salmonids and may result in disease as well as a reduced ability to physiologically adapt to saltwater, avoid predators, forage effectively, and seek and find shelter. Contaminants can be taken up directly through the water column or through contaminated prey.

Predation is a major factor affecting salmonid survival in the Lower Columbia River, estuary and river mouth. Birds, including Western grebes, cormorants, gulls, terns, and great blue herons, are known to prey on salmonids. Piscine and pinniped predators also may prey salmonids. Suspended solids, which can be a major contributor to turbidity, may affect survival by reducing the ability of salmonids to see prey, and indirectly cause mortality via starvation. Temperature and salinity extremes typically stress fish, which may lead directly or indirectly to mortality. Stranding can occur when fish are washed up onto higher ground by waves or ship wakes, or if they are caught for extended periods of time in a shallow pool during an extended low tide. Fisheries biologists have observed stranding of salmonids in the Lower Columbia River system. Entrainment refers to the uptake of fish during dredging. Finally, competition between and among members of the outmigrating salmonid populations may play a role in survival; however, little is understood or documented regarding the effects of competition in the Lower Columbia River, estuary and river mouth.

4.3 Essential Features of Designated Critical Habitat

The NMFS designates critical habitat based on physical and biological features that are essential to the listed species. The essential features of designated critical habitat (see Table 1.1) within the action area that support successful migration, smoltification, and rearing for ESA-listed salmonids include: (1) Substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food (primarily juvenile), (8) riparian vegetation, (9) space, and (10) safe passage conditions. The proposed Project may affect the following five essential features: Substrate, water quality, food, riparian vegetation, and safe passage conditions resulting from the proposed action. The conceptual ecosystem model used to assess Project effects in this Opinion considers the essential features of critical habitat in its characterization of the physical and biological interactions of the Lower Columbia River, estuary and river mouth.

5. ENVIRONMENTAL BASELINE

5.1 Introduction

The status of the ESA-listed salmonids in the Project area, and their risk of extinction, have not significantly changed since the species were listed. The NMFS is not aware of any new data that would indicate otherwise. The environmental baseline, to which the effects of the proposed action are added, "include the past and present impacts of all Federal, State or private activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation process" (50 CFR Section 402.02).

The biological requirements of ESA-listed salmonids are currently not being met under the environmental baseline. The species status is such that there needs to be significant improvement in the current environmental baseline conditions, including the condition of any designated critical habitat. A substantial proportion the tidal marsh and swamp habitats that support migration, smoltification, and rearing have been lost or degraded by shoreland development, diking, dredging, and filling activities. A primary goal of habitat restoration in the Lower Columbia River and estuary is to increase the survival and recovery of salmon by restoring the spatial and temporal diversity and connectivity of habitats available that provide these biological requirements.

The discussion of the Environmental Baseline, below, is presented in two sub-sections. The first sub-section provides an overview of the current environmental conditions in the Lower Colombia River and estuary. The second sub-section provides current information on ESA-listed salmonids of the Lower Columbia River and estuary, and discusses the importance of the Lower Columbia River and estuary's physical processes and resultant habitats to those species.

5.2 Environmental Condition of the Lower Columbia River and Estuary

The Columbia River is naturally a very dynamic system. It has been affected and shaped over eons by a variety of natural forces, including volcanic activity, storms, floods, natural events, and climatological changes. These forces had and continue to have a significant influence on biological factors, habitat, inhabitants, and the whole riverine and estuarine environment of the Columbia River.

Over the past century, human activities have dampened the range of physical forces in the action area and resulted in extensive changes in the Lower Columbia River and estuary. To a significant degree, the risk of extinction for salmon stocks in the Columbia River basin has increased because complex freshwater and estuarine habitats needed to maintain diverse wild populations and life histories have been lost and fragmented. Estuarine habitat has been lost or altered directly through diking, filling, and dredging. Estuarine habitat has also been removed indirectly through changes to flow regulation that affect sediment transport and salinity ranges of specific habitats within the estuary. Not only have rearing habitats been removed, but the connections among habitats needed to support tidal and seasonal movements of juvenile salmon have been severed.

The Lower Columbia River estuary has lost approximately 43% of its historic tidal marsh (from 16,180 to 9,200 acres) and 77% of historic tidal swamp habitats (from 32,020 to 6,950 acres) between 1870 and 1970 (Thomas 1983). One example is the diking and filling of floodplains formerly connected to the tidal river, which have resulted in the loss of large expanses of low-energy, off-channel habitat for salmon rearing and migrating during high flows. Similarly, diking of estuarine marshes and forested wetlands within the estuary have removed most of these important off-channel habitats. Sherwood et al. (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970.

The total volume of the estuary inside the entrance has declined by about 12% since 1868. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production. Sherwood et al. (1990) also analyzed early navigational charts and noted profound changes in the river entrance from year to year. The pre-development river mouth was characterized by shifting shoals, sandbars, and channels forming ebb and flood tide deltas. Prior to jetty construction, the navigable channel over the tidal delta varied from a single, relatively deep channel in some years to two or more shallow channels in other years.

Within the Lower Columbia River, diking, river training devices (pile dikes and rip rap), railroads, and highways have narrowed and confined the river to its present location. Between the Willamette River and the mouth of the Columbia River, diking, flow regulation, and other human activities have resulted in a confinement of 84,000 acres of flood plain that likely contained large amounts of tidal marsh and swamp. The Lower Columbia River's remaining tidal marsh and swamp habitats are located in a narrow band along the Columbia River and tributaries' banks and around undeveloped islands.

Since the late 1800s, the Corps has been responsible for maintaining navigation safety on the Columbia River. During that time, the Corps has taken many actions to improve and maintain the navigation channel. The channel has been dredged periodically to make it deeper and wider, as well as annually for maintenance. To improve navigation and reduce maintenance dredging, the navigation channel has also been realigned and hydraulic control structures, such as in-water fills, channel constrictions, and pile dikes, have been built. Most of the present-day pile dike system was built in the periods 1917-23 and 1933-39, with an additional 35 pile dikes constructed between 1957 and 1967.

The existing navigation channel pile dike system consists of 256 pile dikes, totaling 240,000 linear feet. Ogden Beeman and Associates (1985) termed these Corps activities "river regulation", and noted that navigation channel maintenance activities, for a 100-year period prior to their 1985 report, required closing of river side channels, realigning river banks, removing rock sills, stabilizing river banks, and placement of river "training" features. Most of these baseline river training features and habitat alterations were constructed or occurred before any of the current ESA-listed salmonids were placed on the list of endangered and threatened species.

Flow regulation, water withdrawal and climate change have reduced the Columbia River's average flow and altered the seasonality of Columbia River flows, sediment discharge and turbidity, which have changed the estuarine ecosystem (National Research Council, 1996; Sherwood et al., 1990; Simenstad et al., 1990, 1992, Weitkamp, 1994). Annual spring freshet flows through the Columbia River estuary are approximately one-half of the traditional levels that flushed the estuary and carried smolts to sea, and total sediment discharge is approximately one-third of 19th Century levels. For instance, flow regulation that began in the 1970s has reduced the 2-year flood peak discharge, as measured at The Dalles, Oregon, from 580,000 cfs to 360,000 cfs (Corps, 1999).

Decreased spring flows and sediment discharges have also reduced the extent, speed of movement, thickness, and turbidity of the plume that extended far out and south into the Pacific Ocean during the spring and summer (Cudaback and Jay, 1996; Hickey et al., 1997). Changes in estuarine bathymetry and flow have altered the extent and pattern of salinity intrusion into the river and have increased stratification and reduced mixing (Sherwood et al., 1990).

These aforementioned physical changes also affect other factors in the riverine and estuarine environment. Tides raise and lower river levels at least 4 feet and up to 12 feet twice every day. The historical range for tides was probably similar, but seasonal ranges and extremes in water surface elevations have certainly changed because of river flow regulation. The salinity level in areas of the estuary can vary from zero to 34 parts per thousand (ppt) depending on tidal intrusion, river flows, and storms. Flow regulation has affected the upstream limit of salinity intrusion. The salinity wedge is believed to have ranged from the river mouth to as far upstream as RM 37.5 in the past. It is now generally believed that the salinity intrusion ranges between the mouth and RM 30. The river bed within the navigation channel is composed of a continuously moving series of sand waves that can migrate up to 20 feet per day at flows of 400,000 cfs or greater, and at slower rates at lesser flows. This rate of river discharge is not experienced as often as it was prior to flow regulation in the Columbia River.

Development has changed the circulation pattern in the estuary and increased shoaling rates. Sediment input to the estuary has declined due to the altered hydrograph and the estuary is now a more effective sediment trap (Northwest Power Planning Council, 1996). Although the Columbia River is characterized as a highly energetic system, it has been changing as a result of development and is now similar to more developed and less energetic estuaries throughout the world (Sherwood, et al., 1990).

Water quality is another important aspect the environmental condition of the Lower Columbia River and ecosystem that the potential to affect salmonid's growth and survival. The uptake of toxicants during juvenile salmonid residence in the Lower Columbia River and estuary (NWFSC Environmental Conservation Division 2001) can affect their growth and survival. In field studies, juvenile salmon from sites in the Pacific Northwest show demonstrable effects, including immunosuppression, reduced disease resistance, and reduced growth rates, due to contaminant exposure during their estuarine residence (Arkoosh et al. 1991, 1994, 1998; Varanasi et al. 1993; Casillas et al. 1995a,b, 1998a).

Current environmental conditions in the Columbia River estuary indicate the presence of contaminants in the food chain of juvenile salmonids. Fish from a site near Sand Island, in the mouth of the Columbia River, whole body concentrations of dichlorodiphenyl trichloroethane (DDT) and polychlorinated biphenyls (PCB) were 44 ng/g wet wt (~ 220 ng/g dry wt) and 53 ng/g wet wt (~ 265 ng/g dry wt), respectively (Fig. 6)[NWFSC Environmental Conservation Division 2001]. The findings of elevated levels of DDTs and PCBs in stomach contents of fish from Sand Island, however, is clear evidence that fish are being exposed to these contaminants while they are in the estuary. Levels of DDTs in stomach contents were 52 ng/g wet weight, and levels of PCBs were 33 ng/g wet weight. Although the Sand Island samples were collected from a mixed population of hatchery and wild fish and it is likely that DDTs and PCBs in hatchery food make some contribution to contaminant body burdens, the values seen were among the highest levels measured at estuarine sites in Washington and Oregon. By comparison, in the Duwamish estuary, a heavily contaminated industrial estuary near Seattle, mean whole body DDT levels in juvenile chinook salmon were 25 ng/g wet wt (~125 ng/g dry wt) and whole body PCB levels were 68 ng/g wet wt (~340 ng/g dry wt)[NWFSC Environmental Conservation Division 2001, Fig. 6].

More recently, additional samples were analyzed from salmon collections in 1999 and 2000 (NWFSC Environmental Conservation Division, 2001). These analyses show that concentrations of PCBs and DDTs are consistently elevated in chinook salmon collected from Sand Island in the mouth of the Columbia River. Measured concentrations of DDTs in salmon bodies ranged from 32 to 56 ng/g dry wt, and concentrations of

PCBs ranged from 23 to 160 ng/g dry wt (NWFSC Environmental Conservation Division 2001, Fig. 8). No significant differences in mean concentrations of either of these contaminants were found over the three years during which fish were sampled. Elevated levels of PCBs and DDTs were also consistently found in stomach contents of sampled fish, indicating that juvenile salmon caught near Sand Island are taking these contaminants up in their diet.

The concentrations of PCBs present in Sand Island fish are a cause for concern, because they are approaching or even exceeding estimated threshold tissue concentrations for adverse effects in salmonids (Meador, 2000). These values range from 120-360 ng/g dry wt for fish with total body lipid concentrations of 1-3%, which are typical of juvenile salmon collected within Pacific Northwest estuaries. At an average of 265 ng/g dry wt, PCB concentrations in Sand Island fish are well within the range of the effects threshold.

Available data suggest that exposure to polyaromatic hydrocarbons (PAH) may be quite variable in juvenile salmon from the Lower Columbia River. In stomach contents of juvenile chinook salmon collected near Sand Island in 1998, PAH concentrations were barely detectable, below levels seen in salmon from moderately developed estuaries such as Yaquina Bay and Grays Harbor, and well below levels found in stomach contents of salmon from industrialized waterways of Puget Sound (e.g., Hylebos Waterway) (NWFSC Environmental Conservation Division 2001, Fig. 9). Similarly, concentrations of PAH metabolites in bile were relatively low in juvenile salmon from Sand Island in comparison to fish from urban Puget Sound sites (e.g., the Duwamish and Hylebos Waterways) (NWFSC Environmental Conservation Division 2001, Fig. 10). Juvenile salmon sampled near Sand Island in 2000, however, showed somewhat greater exposure to PAHs than salmon sampled in 1998. Concentrations of PAHs and their metabolites in both stomach contents and fish bile were considerably higher in 2000 than in 1998 (NWFSC Environmental Conservation Division 2001, Fig. 11). Concentrations were still lower than those observed in fish from urban estuaries in Puget Sound, but were comparable to those observed in fish from moderately development estuaries along the Washington and Oregon coast, such as Yaquina Bay or Coos Bay.

These data indicate that juvenile salmonids within the Columbia River estuary have contaminant body burdens that may already be within the range where sublethal effects may occur, although the sources of exposure are not clear.

5.2.1 Description of the Environmental Baseline for ESA-listed Salmonids the Lower Columbia River and Estuary

All ESA-listed salmonids must pass through the Lower Columbia River, estuary and river mouth twice: once as juveniles en route to the Pacific Ocean and again as adults when they return to spawn. The Lower Columbia River and estuary serve three primary roles for outmigrating juveniles as they transition from shallow freshwater environments to the ocean possible: (1) A place where juvenile fish can gradually acclimate to salt water, (2) a feeding area (i.e., main, and tidal channel, unvegetated shoals, emergent and forested wetlands, and mudflats) capable of sustaining increased growth rates, and (3) a refuge from predators while fish acclimate to salt water.

Thus, though the Lower Columbia River and estuary is important to the survival and recovery of all ESA-listed salmonids, it is particularly important to ocean-type salmon. These stocks may be particularly sensitive to ecosystem changes because of their longer residence times and dependence on this portion of the river for growth and survival. In this consultation, NMFS focused on ocean-type salmon as an indicator of the importance of the Lower Columbia River and estuary to all ESA-listed salmonids. NMFS focused on ocean-type salmon because they are an indicator of the most sensitive salmonid response to changes in estuary and river habitats.

Ocean-type salmon ESUs in the Columbia River include chinook ESUs (Lower Columbia River, Snake River fall, and Upper Willamette River) and Columbia River chum salmon ESUs. These ESUs are the most likely to be affected by potential impacts of the Project, and thus are discussed in detail below. Ocean-type salmon migrate downstream to and through the estuary as subyearlings, generally leaving the spawning area where they hatched within days to months following their emergence from the gravel. Consequently, subyearlings commonly spend weeks to months rearing within the action area prior to reaching the size at which they migrate to the ocean.

Young salmonids must undergo a physiological transition and develop enough strength, energy, and reserve capacity to adapt to and survive the physical and biological challenges of the ocean environment, as well as to successfully obtain prey in that environment. Juvenile salmonids appear to reach the threshold for this transitional state at a size of 70 to 100 mm. Before fish reach this size, their ocean survival would be difficult.

The first outbound migrants of the Lower Columbia River fall chinook and chum may arrive in the action area as early as late February (Herrmann, 1970; Craddock, et al., 1976; Healey, 1980; Congleton, et al., 1981; Healey, 1982; Dawley, et al., 1986; Levings, et al., 1986). The majority of these fish are present from March through June. Outbound Snake River fall chinook begin their migration much farther upstream and arrive in the Lower Columbia River approximately a month later.

Ocean-type subyearlings arrive in the lower river and estuarine portion of the action area at a small size. The earliest migrants can be as small as 30 to 40 mm fork length (i.e., from snout to fork in the tail) when they arrive because some of these fish hatch only a short distance upstream from the action area. Later spring migrants are generally larger, ranging up to 50 to 80 mm. Subyearlings from the mid-Columbia and Snake Rivers tend to be substantially larger (70 to 100 mm) by the time they reach the Lower Columbia River. The larger size of the Lower Snake River fall chinook, compared with the Lower Columbia River chinook and chum, likely indicates some differences in suitable habitat. The larger subyearlings from the Snake River can likely use a greater range of depth and current conditions than the subyearlings of the Lower Columbia River ESUs can.

Once ocean-type subyearlings arrive in the Lower Columbia River, they may remain for weeks to months. Because these fish arrive small in size, they undergo extended lower river and estuary rearing before they reach the transitional size necessary to migrate into the ocean (70 to 100 mm). This larger size is necessary to deal with the physical conditions and predators they face in the ocean environment, as well as to be successful in obtaining prey in that environment. At growth rates of about 0.3 to 1 mm per day (Levy, et al., 1979; Argue et al., 1985; Fisher and Pearcy, 1990), the subyearlings require weeks to months to reach this larger size. During this time, young chinook increase by about 5 to 8 grams per day or approximately 6 percent of their body weight (Herrmann, 1970; Healey, 1980).

Ocean-type subyearlings migrate through the riverine reach of the action area of the Project during their downstream migration (about 150 kilometers [km]). Because of this, many spend some time rearing within the riverine reach; however, there is considerable variability in the freshwater rearing period of subyearling populations. Some subyearlings spawned in the lower reaches of coastal tributaries migrate almost immediately to marine areas following emergence from the gravel. Other subyearlings rear in freshwater for weeks to months, particularly those spawned well upstream in larger river systems such as the Columbia. The migration rate for subyearlings undergoing the rearing migration through the riverine reach is likely to be a few to ten km per day. Subyearlings migrating directly to the estuary migrate at rates of 15 to 30 km per day (MacDonald, 1960; Simenstad, et al., 1982; MacDonald, et al., 1987; Murphy, et al., 1989; Fisher and Pearcy, 1990). Adult salmon returning to the Columbia River migrate through the river mouth throughout the year. The majority move through this area from early spring through autumn.

A number of physical characteristics in the riverine reach affect the quality and quantity of habitat available for salmonids. These include the availability of prey, temperature, turbidity, and suspended solids. Subyearlings are commonly found within a few meters of the shoreline at water depths of less than 1 meter. Although they migrate between areas over deeper water, they generally remain close to the water surface and near the shoreline during rearing, favoring water no more than 2 meters deep and areas where currents do not exceed 0.3 meter per second. They seek lower energy areas where waves and currents do not require them to expend considerable energy to remain in position while they consume invertebrates that live on or near the substrate. These areas are characterized by relatively fine grain substrates. However, it is not uncommon to find young salmonids in areas with steeper and harder substrates, such as sand and gravel.

Young chinook in the Lower Columbia action area consume a variety of prey—primarily insects in the spring and fall and *Daphnia* from July to October (Craddock, et al., 1976). *Daphnia* are the major prey during the summer and fall months, selected more than other planktonic organisms. Young salmonids consume diptera, hymenoptera, coleoptera, tricoptera, and ephemeroptera in the area just upstream from the estuary (Dawley, et al., 1986). Bottom and Jones (1990) recently reported that young chinook ate primarily *Corophium*, *Daphnia*, and insects, with *Corophium* being the dominant prey species in winter and spring and *Daphnia* the dominant prey species in summer. Salmonids commonly feed on *Corophium* males, which apparently are more readily available than the larger females.

Corophium is commonly discussed as a primary prey item of juvenile salmonids in the Lower Columbia River. *Corophium salmonis* is a euryhaline species tolerating salinities in the range of zero to 20 ppt (Holton and Higley, 1984). As shown by the above investigations, it is one of several major prey species consumed by juvenile chinook under existing conditions. No data are available that indicate its historical role in the diet of Columbia River salmon prior to substantial modification of the river system. Nutritionally, *Corophium* may not be as desirable as other food sources for young salmon. According to Higgs, et al. (1995), gammarid amphipods such as *Corophium* are high in chitin and ash and low in available protein and energy relative to daphnids and chironomid larvae.

Subyearling chinook and chum first enter the estuary at about the same time that they enter the riverine potion of the Lower Columbia River because some of the fry move rapidly to the estuary by mid-March rather than rearing in the riverine areas (Craddock, et al., 1976; Dawley, et al., 1986; Levy and Northcote, 1982; Healey, 1982; Hayman, et al., 1996). As chinook fry migrate to the estuary, they may remain in the low salinity or even freshwater areas for some time until they have grown somewhat larger (more than 75 mm) (Kjelson, et al., 1982; Levings, 1982; Levy and Northcote, 1982; MacDonald, et al., 1986; Shreffler et al., 1992; Hayman, et al., 1996). However, some chinook fry appear to move immediately to the outer edges and higher salinity portions of the estuary (Stober, et al., 1971; Kask and Parker, 1972; Sibert, 1975; Healey, 1980; Johnson, et al., 1992; Beamer, et al., 2000).

Ocean-type fish commonly have the capacity to adapt to highly saline waters shortly after emergence from the gravel. Tiffan, et al. (2000), determined that, once active migrant fall chinook passed McNary Dam 470 km upstream from the Columbia River's mouth, 90 percent of the subyearlings were able to survive challenge tests in 30 ppt seawater at 18.3?C. Other investigators have found that very small chinook fry are capable of adapting to estuarine salinities within a few days (Ellis, 1957; Clark and Shelbourn, 1985). Wagner, et al. (1969), found that all fall chinook alevins tested were able to tolerate 15 to 20 ppt salinity immediately after hatching.

While tidal exchange with the ocean tends to keep estuary temperatures at moderate levels (ten to 20?C) throughout the time the outmigrants are present, spring and summer temperatures vary widely in shallow water when tidal flats are exposed by low tides during sunny midday periods. Consequently, young salmonids rearing in shallow water naturally experience a wide range of temperatures within periods of less than a day. The available observations of the behavioral reaction of young salmonids to temperatures in estuarine conditions are variable. Bessey (1976) found hatchery chinook and wild chum avoided water of 16° C. These fry responded immediately to increases of less than 1? C; however, the fry did not avoid rapid increases of more than 1? C per minute. Temperatures in the estuarine reach may range from zero to 26? C, but 12? to 14? C is optimum for young salmon (Bottom, et al., 2001).

In the estuary, turbidity is important in relation to the ETM zone. Relatively high turbidity is a characteristic of the intermixing of freshwater and saltwater in the ETM. However, Jones, et al. (1990), concluded that, in the Lower Columbia River, the standing stocks of benthic animals were highest in the protected tidal flat habitats, while those of epibenthic and zooplanktonic organisms were concentrated within the ETM. Because prey species have differing tolerances for salinity, increased salinity in the estuary results in different prey species being available to the rearing fry than those in the freshwater riverine reach, and in a change in the abundance of those prey species that are found in both the estuarine and riverine reaches.

In addition, young salmonids in the estuary continue to eat many of the same organisms as are consumed in the riverine reach of the Lower Columbia River, but there are shifts in prey abundance. Young chinook and chum at Miller Sands in the upper estuarine reach feed primarily on the pelagic prey *Daphnia longispina* and *Eurytemora hirundoides,* the benthic prey *Corophium salmonis*, and chironomid larvae and pupae (McConnell, et al., 1978). Diet overlaps considerably among the different species. Many yearlings passing through the lower river were found to have empty or less than full stomachs (Dawley, et al., 1986).

As young salmonids leave the estuary, they migrate through the river mouth. At the river's mouth, there tends to be more wave and current energy than other portion of the estuary. The ocean area immediately outside the river mouth is characterized by high salinity during low to moderate flows and by high wave energy with no shoreline for protection. It is likely that young salmonids pass through the river mouth from March through the autumn months during the same time they are present in the estuary. Some individuals may migrate out of the estuary early and other late in the general migration period of each ESU.

Outside the river mouth, young salmonids enter the ocean, where high salinity and the absence of available shoreline require them to adapt to a pelagic life style. Pearcy, et al. (1990), found chinook in near-surface waters up to 46 km offshore from Oregon and Washington during the summer months, but absent from this area by mid-September. Orsi, et al. (2000), found juvenile chinook, chum, and pink salmon were most abundant in the shoreline (strait) waters of southeast Alaska during June and July when zooplankton abundance was highest. Food availability may also be a factor in the timing of Columbia River salmon migration; however, Brodeur (1992) concluded that food availability off the Oregon and Washington coasts was not a limiting factor.

Adult salmon returning to the Columbia River migrate through the river mouth throughout the year. The majority move through this area from early spring through autumn.

6. EFFECTS OF THE PROPOSED ACTION

6.1 Introduction

The proposed Project has several distinct components, including Project construction and maintenance activities, monitoring and adaptive management, and ecosystem restoration and research actions. The Effects of the Proposed Action Section includes sub-sections that address each Project component separately. Section 6.8 of this Opinion summarizes the effects analysis. Section 9 then provides our conclusion whether the Project, as a whole, jeopardizes the continued existence of ESA-listed salmonids, or results in the destruction or adverse modification of their designated critical habitat. This is accomplished by aggregating effects to each pathway and indicator, when considered together with effects from interrelated and interdependent actions, cumulative effects and the environmental baseline.

As noted in Section 3.2, Description of the Proposed Action, several steps were involved in development of the current proposed action. Those steps included a re-evaluation of potential Project effects, an analysis of these potential effects within the framework of an ecosystem-based conceptual ecosystem model, the development of compliance measures and monitoring conditions to minimize and/or avoid Project impacts, and the development of an adaptive management process to review information from the compliance and monitoring activities and make necessary Project modifications to minimize and/or avoid impacts. By using this "frontloading" approach, NMFS and the Corps defined a proposed action that minimized or avoided Project-related effects. Therefore, some of the indicators identified in the conceptual ecosystem model are not discussed in this Opinion because the Corps' proposed action successfully avoids effects to them (see Table 2-1 of the 2001 BA for indicators not included for analysis in this Opinion).

NMFS used the conceptual model, numerical models, and the results of BRT deliberations to analyze potential project effects. The pathways and indicators defined in the conceptual ecosystem model (see Chapter 5 of the 2001 BA) are used herein as a framework to discuss potential Project effects. Pathways and indicators that could be potentially affected by the Project are addressed in Sections 6.2.1 and 6.2.2.

To determine specific physical habitat changes (salinity, velocity, depth) that might occur after Project implementation, the BRT used two numerical models, the Corps of Engineers – Waterways Experiment Station (WES) RMA-10 model and the Oregon Health Sciences University/Oregon Graduate Institute (OHSU/OGI) Eulerian – Lagrangian CIRCulation (ELCIRC) model. The BRT was also assisted by the SEI panel process, which reviewed multiple aspects of the proposed Project (e.g., historical and existing status of the Lower Columbia River ecosystem, numerical modeling of hydraulic parameters, including flow and bathymetry; salmonid estuarine ecology; sediments and sediment quality, and monitoring and adaptive management). The 2001 BA (see Section 6 and Appendices B, F, and G) provides a complete overview of these analysis techniques and results of quantitative analyses and modeling outputs, and is incorporated herein by reference.

The above analyses addressed the concerns raised in NMFS'August 25, 2000, biological opinion withdrawal letter. The SEI panel process was used to respond to the concerns raised in our August 25, 2000 withdrawal letter, helped to frame major concerns raised in connection with the proposed Project, and identified best available science for additional analysis of Project effects. The Corps also conducted additional numerical modeling for the Lower Columbia River and estuary (see above discussion).

To develop the effects analysis for the 2001 BA, the BRT utilized the scientific information identified during the SEI panel process, including the best available science provided by NMFS' Northwest Fisheries Science Center, which describes the effects of bathymetry on ecological conditions of the estuary, and new information regarding potential effects of contaminants that could be released by Project activities. This best available scientific data and information was also used in developing the Terms and Conditions identified in Section 9 of this Opinion, the Incidental Take Statement.

The issue of NMFS potentially designating new critical habitat was also raised in our August 25, 2000 withdrawal letter. Subsequently, critical habitat was designated for the ESA-listed salmonids considered in this consultation. The five critical habitat elements relevant to designated critical habitat that could be potentially impacted by the Project (riparian vegetation; water quality; substrate; food; and safe passage) were included in the development of the conceptual ecosystem model, and were analyzed as part of the effects analysis (see Sections 6.2 - 6.7 of this Opinion).

NMFS also expressed concern regarding the Corps' ability to restore estuarine habitats as identified in the 1999 biological opinion. This concern has also been resolved. In their 2001 BA, the Corps proposed an expanded set of ecosystem restoration features (see Table 8-2 of the 2001 BA) that are included in the proposed action that the Corps has committed to implement. These restoration actions will be funded by the Corps as integral Project components.

The following analysis of potential direct and indirect effects to salmonids and their habitats (Sections 6.2 - 6.7 of this Opinion) from construction and maintenance activities uses the conceptual model indicators and focuses on Project-related effects to key habitat types. This section also discusses interrelated and interdependent actions and their associated effects. Uncertainty regarding Project-related effects and associated risk to ecosystem indicators is presented, along with monitoring and adaptive management measures proposed by the Corps to reduce Project-related risk and uncertainty. This section of the Opinion also addresses potential effects resulting from proposed monitoring, ecosystem restoration, and research proposals. Finally, NMFS' conclusions on overall Project-related effects are presented.

6.2 Effects from Construction and Maintenance Activities

Project construction, maintenance, and compliance activities may have immediate (direct) effects to salmonids, as well as short-term and long-term (indirect) effects to ecosystem processes and functions of importance to salmonids. Additional activities, interrelated to the proposed action, may also have indirect effects to ESA-listed salmonids. NMFS uses the pathways and indicators from the conceptual ecosystem model as an analytical framework for discussing indirect effects from construction and maintenance activities. NMFS assumed that, if a pathway or indicator is influenced by the Project, then an indirect, short- or long-term impact to salmonids and their habitats may also may occur.

6.2.1 Direct Effects

Direct mortality to salmonids from construction and maintenance activities could occur from entrainment during dredging, disposal, or during in-water blasting activities. Direct effects to critical habitat may occur from dredging and disposal activities, implementation of wildlife mitigation measures and implementation of ecosystem restoration features.

NMFS assumes that any salmonid entrained by the dredging activities will suffer injury or perish. Entrainment of organisms by hopper dredging has been evaluated at the mouth and in the Columbia River (Larson and Moehl, 1990; R2 Resources Consultants, 1999). Larson and Moehl (1990) reported that no juvenile or adult salmonids were collected during the four years of the study, even though other pelagic fish species were collected. This study concluded that, because dredging occurred below the depth where salmonids migrate, no salmonids were entrained. Documented entrainment of salmonids occurred during a research study in which the dredge draghead was purposely operated while elevated in the water column instead of within the substrate to determine presence/absence of fish (R2 Resource Consultants 1999). This entrainment incident involved two salmonids. No juvenile salmonids have been entrained during monitored, normal dredging operations in the Columbia River (Larson and Moehl 1990).

Under the Corps' proposed Project dredging procedures, the draghead and/or cutterhead will be buried, to the extent possible, in the sediment of the river bed during dredging operations. No suction will occur through the draghead and/or cutterhead if it is raised more than 3 feet off the river bottom. Both these proposed "impact minimization" measures reduce the potential for juvenile salmonid entrainment.

Observations of sub-yearling and juvenile ESA-listed salmonid distribution and relative vulnerability to dredging entrainment impacts were conducted in the Lower Columbia River (Carlson et al., 2001). Research indicated that the majority of salmonids were not utilizing the bottom of the navigation channel, where entrainment might occur during dredging activities. Analysis of hydroaccoustic sampling data revealed that, during the highest ESA-listed fish annual abundance in the Lower Columbia River, only 0.0017 percent of those fish were adjacent to the dredging zone (within three feet of the navigation channel bottom) during the daylight hours; 0.0249 percent were adjacent to the dredging zone in the evening hours, and 0.0107 percent were adjacent to the dredging zone at night (Carlson et al., 2001). The combination of very limited occupancy by ESA-listed salmonids of deep water locations, and BMPs that restrict dredge draghead or cutterheads to be operated, to the extent possible, under the sediment surface, will ensure that entrainment of ESA-listed salmonids is minimized. It is believed that adult salmonids have sufficient swimming capacity to avoid entrainment, and are further protected by the dredging "impact minimization" actions noted above. NMFS believes that compliance monitoring, to ensure the proposed entrainment minimization measures are implemented, will be important in minimizing any injury or death of salmonids during dredging activities.

One location (Warrior Rock, RM 87.3) may require one-time in-water blasting. NMFS anticipates blasting could injure or kill salmonids within the blasting area. However, the proposed action minimizes potential direct effects by requiring a blasting plan, using an in-water work window of November 1 to February 28 when salmonid abundance is lowest, and reducing the associated pressure wave by creating an implosion. NMFS believes reducing implosion-induced over-pressure to less than ten psi will minimize blast-related impacts to salmonids. NMFS believes that development of a NMFS-approved monitoring plan, that ensures the proposed blasting measures are implemented, will be important to minimize any injury or death of ESA-listed salmonids during blasting activities.

Dredge material disposal has the potential to cause direct effects to ESA-listed salmonid habitat along the Columbia River. Disposal areas were sited primarily on existing dredged material disposal sites or at locations behind flood control dikes. Typically, these disposal sites provide negligible inputs (e.g., detrital and insect faunal export, large woody debris export) to the Columbia River, and thus are of limited value to ESA-listed salmonids. As a result, direct effects of dredged material disposal are not expected to be significant.

Habitat development, principally riparian and wetland habitats, is the principal thrust for restoration actions. Restoration actions at Webb and Woodland Bottoms locations would occur behind flood control dikes under the current prescription. Insect faunal export from these locations would occur although not as substantial as for locations directly connected to the Columbia River. Development of intertidal marsh and riparian forest habitat at Martin Island would occur on lands directly connected to the Columbia River and the direct effect of this action would be more beneficial than the other two restoration sites. Insect and detrital export, along with large woody debris export would be expected at Martin Island. Ecosystem restoration features are proposed at in-water sites (Miller-Pillar, Lois Island Embayment, and Bachelor Slough) and would result in initial, temporary adverse direct effects to critical habitat features, but over the long-term would produce beneficial effects greater than current baseline conditions.

Ecosystem restoration features at Tenasillahe Island (interim and long-term) and for tidegate improvements have temporary direct effects to designated critical habitat associated with construction, but long term, the direct effects to critical habitat of these actions will improve access to a larger habitat base and improved export of vegetative detritus, insect fauna and large woody debris. The introduction of white-tailed deer at Cottonwood-Howard Island has no direct effect on ESA-listed salmonids or designated critical habitat.

The proposed development and implementation of an integrated pest management strategy to control the noxious weed purple loosestrife may have a limited direct effect on ESA-listed salmonids or designated critical habitat. In the long term, maintenance and enhancement of intertidal marsh habitat and native plant communities would maintain current baseline conditions or improve them over time.

The restoration feature to improve embayment circulation at Lord-Walker and Fisher-Hump Islands would result in initial, temporary adverse direct effects to elements of critical habitat, but over the long term would improve habitat conditions for ESA-listed salmonids.

The proposed restoration feature at Shillapoo Lake occurs behind flood control levees where there is currently no access by ESA-listed salmonids. Construction impacts to wetland habitats would be contained behind the levees and would not affect ESA-listed salmonids..

6.2.2 Indirect Effects

The 2001 BA determined that, of the 38 conceptual ecosystem model indicators that potentially could be influenced by the Project’s construction, maintenance, and effects minimization activities, a total of 20 indicators of ecosystem process and function may be influenced. After review of the conceptual ecosystem model (see Chapter 5 of the 2001 BA) and the effects analysis in the 2001 BA (see Chapter 6), NMFS analyzed five habitat forming process indicators (suspended sediment, bedload, turbidity, salinity, bathymetry) and three key habitat types (tidal marsh and swamp, shallow water and flats, and water column) associated with physical and biological indicators that could be potentially be affected by the Project.

The seven key indicators (insects, macrodetritus, microdetritus, benthic algae, deposit feeders/suspension-deposit feeders/suspension, mobile macroivertebrates, and phytoplankton) that link the prey base to ESA-listed salmonids are integrated into the discussion of key habitat types in which they are primarily found. The habitat complexity, connectivity, and conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability indicators are analyzed as a grouping because they can affect more than one habitat type, and this grouping better reflects an ecosystem approach to impact assessment.

The final indicator analyzed, fish stranding, potentially results from deep-draft vessel traffic that is interdependent to the Project, and is thus addressed in Section 6.5 of this Opinion.

6.2.2.1 Ecosystem Indicator - Suspended Sediment (including an analysis of accretion and erosion)

Proposed dredging and disposal actions and future interrelated activities may influence suspended sediment concentrations in the Lower Columbia River, estuary and river mouth. In areas adjacent to dredges and shoreline disposal operations, increases in suspended sediment concentrations may temporarily increase local water column turbidity.

Dredging operations are likely to cause downstream suspended sediment increases of zero to two mg/L, depending on the number and type of dredges operating. Most of the dredging and disposal-induced suspended sediment should rapidly settle onto adjacent substrates. Ocean disposal will result in longer periods of sediment suspension before the sediment settles onto the deepwater substrate. Based on the data indicating that less than one percent of the dredged material is fine enough to remain in suspension following disposal, the Corps estimates that disposal of construction-related dredging will contribute up to 180,000 cubic yards of suspended sediments over the two year construction period.

Background suspended sediment loads for the same two year period have been estimated at four mcy. The Project would have a maximum increase of 4.5 percent in the suspended sediment load and generally equates to less than one mg/L increase in suspended sediment concentrations. It is likely that these volumes will have limited influence on accretion and erosion in important salmonid habitat areas.

Contaminants associated with dredged and disposed sediments may be resuspended in the ecosystem. Contaminants are discussed in Section 6.4.2 below. However, much of the material to be dredged from the navigation channel will originate from existing sand waves, a dynamic natural feature of the river bottom, that are constantly on the move due to current action. These sand waves contain a small percentage of fine sediments and organic material, thus have the potential to carry a limited amount of contaminants into natural resuspension from current action or dredging and disposal.

Dredged materials from Project berth areas are higher in silts and clays, and may have higher potential to create suspended sediments while dredging is occurring, as well as higher potential for associated contaminant resuspension. Materials resuspended by dredging and disposal activities may accumulate within the ETM, and be redistributed into lateral habitats of importance to salmon. The effects of the deposition of additional fine sediments into lateral habitats may be beneficial to those habitats, or detrimental due to the presence of contamination. Resuspension of contaminants related to the Project are further described below. Interrelated and/or interdependent activities, such as deepening of adjacent ports and berths can also have similar influence on suspended sediments. Ship wakes, interrelated to the Project, will cause limited increases in suspended sediment, however, the deepened channel may result in less ship traffic and overall less ship wake-induced suspended sediment.

NMFS believes that Project-related changes to suspended sediment could affect the habitat-forming process of sediment accretion and erosion. The Project-related addition to the suspended sediment load may result in a limited increase in accretion of sediment in lateral habitat areas. However, it is unlikely that this Project effect will have any significant benefit to habitats used by ESA-listed salmonids. As noted above, the effect of turbidity increases from Project activities is discussed in Section 6.2.2.3, below.

6.2.2.2 Ecosystem Indicator - Bedload (including an analysis of accretion and erosion)

Riverbed side-slope adjustments and some shoreline erosion are predicted to alter the accretion and erosion patterns within shallow water and flats habitat in the Lower Columbia River at five locations – RM 99, 86, 75, 72, and 46 through 42. A single location in the estuary, RM 22.5, is projected to experience riverbed side-slope adjustments. These six locations are all historic dredge material disposal sites, and provide limited salmonid habitat.

The side-slope adjustment process will take five to ten years to occur after construction. Over that time, shallow water and flats habitat at six shoreline disposal sites will tend to erode toward the shoreline and become deeper. The Corps determined that side-slope adjustments will not occur in natural shoreline areas because these riverbanks are stable, indicating that it is unlikely that tidal marsh and swamp habitat would be affected by side-slope adjustments. The Corps proposes to monitor for any impacts from side-slope adjustments to riparian habitats, including tidal marsh and swamp habitat. This information will enable the Corps and NMFS to track and react to potential changes in side-slope adjustment.

Sand from upstream areas is one of the sources of material for habitat-forming processes (accretion) in the estuary. This sand is important to the formation of tidal marsh and swamps and shallow water and flats habitat. The removal of sand from the river via dredging and upland disposal will not alter the ongoing, natural sediment transport process towards the estuary. The volume and rate of the bedload movement is not expected to change with Project activities. The volume of sand to be dredged over the life of the Project represents a small fraction of the total volume of sand in the riverbed. In addition, transport potential, rather than sand supply, is the limiting factor in sediment supply to the estuary. Therefore, it is likely that the impact to bedload processing of sand removal associated with the Project will be of a limited nature.

NMFS believes that Project-related effects to bedload may alter potential habitat for ESA-listed salmonids at one estuarine and five riverine sites. Predicted side-slope adjustments could harm these species' aquatic habitat by alteration of shallow water, shoreline habitat. Shoreline habitats provide important feeding and rearing areas for these species, therefore any effects to these habitats, above those effects or locations predicted in the 2001 BA, are important to monitor and address.

However, these six shoreline sites are highly erosive and unstable, and do not provide high quality habitat for ESA-listed salmonids. Additional effects discussion regarding side-slope adjustment is provided in Section 6.3, below.

6.2.2.3 Ecosystem Indicator - Turbidity

Turbidity affects the ability of light to penetrate into water, and in turn, affects the amount of plant growth that can occur. This is important for habitat development, particularly in the shallow water areas, because the plant growth adds stability and reduces the chance for erosion. Turbidity plumes resulting from Lower Columbia River and estuary dredging and disposal occurs in a "near field" area (Carlson et al., 2001). Increased turbidity from these Project activities are below the known turbidity levels that stimulate avoidance response by juvenile salmonids, as identified by Servizi and Martens (1992).

Some temporary and localized changes to river and estuary turbidity levels are anticipated to occur from the Project. Localized turbidity levels from Project construction and maintenance activities, five to 26 NTUs above background levels, are not likely to produce detectable effects on plant growth in the lower river or estuary. Increased turbidity will be localized to deep water areas where dredging and in-water disposal will occur. These limited increases to Columbia River and estuary turbidity levels will occur in deeper water areas where the majority of ESA-listed salmonids' migration and feeding activities are not occurring. Local turbidity increases in shallow water areas will occur during shoreline disposal. Ocean disposal will result in localized and short-lived periods of increased turbidity. While high levels of turbidity are known to affect salmonid physiology and feeding success, the combined background and project-related turbidity concentrations are well below known salmonid impact levels (see 2001 BA Sections 4 and 6.1.4).

6.2.2.4 Ecosystem Indicator - Salinity

The concentration of salinity in important habitat and rearing areas of the estuary and the longitudinal gradient of salinity between the freshwater and ocean environments that bound the estuary are important to salmonid growth and survival. The Project will change the estuary's cross-sectional profile and have associated effects on estuary salinity gradients. Based on the WES RMA-10 and OHSU/OGI modeling, the largest Project-related impacts on salinity profiles occur at the lowest river flow analyzed (70,000 cfs).

In shallow areas of Cathlamet Bay and Grays Bay, where important juvenile salmonid habitat and food resources exist, the WES RMA-10 model predicted a post-Project salinity increase of 0.1 to 0.15 ppt. The OHSU/OGI model confirmed these predictions. Within the deeper navigation channel, where limited juvenile salmonid habitat and food resources exist, the WES RMA-10 model predicted post-Project salinity increases in the range of 1.0 to 1.5 ppt. The OHSU/OGI model confirmed these findings, but predicted slightly larger increases in salinity than those predicted by WES RMA-10 modeling for Youngs Bay and along the Oregon side of the navigation channel up to Tongue Point.

Modeling runs for higher river flows indicated even smaller post-Project salinity increases in important salmonid habitats. The OHSU/OGI model also was used to determine if, post-Project, there would be a significant change in habitat opportunity, as defined by Bottom et al. (2001) and the SEI workshop process. Using the OHSU/OGI model an example of the potential changes to habitat opportunity was developed by modeling Cathlamet Bay for five one-week model simulations (see Table 6-1 of the 2001 BA). The model predicted, for important, shallow water Cathlamet Bay salmonid habitats, there was virtually no difference in the habitat opportunity, pre- and post-Project, for salinity between 0-5 ppt.

Changes to the ETM can effect phytoplankton, nutrient cycling, and availability of salmonid prey primarily within the estuary. Changes in salinity as a result of the Project could result in a permanent shift in the boundaries of the ETM, of up to one mile upstream This upstream movement will affect the location where imported phytoplankton die, and with other accumulated organic matter, are cycled through the estuary system. A change in the location and range of the ETM may affect the distribution of nutrients and thereby the location and abundance of salmonid food in shallow water habitats.

While it is believed salmonids do not feed in the ETM, nutrient cycling from the ETM may transfer to shallow water habitats and to the food items which juvenile salmonids prey on. No change in type or quantity of imported phytoplankton is anticipated in the short-term, and short-term effects to salmonids from predicted shifts in ETM, and subsequent modification in nutrient cycling, is anticipated to be limited. However, long-term impacts of the predicted shift in the ETM, based on potential changes to phytoplankton and nutrients (see Table 7-1 of the 2001 BA) over the Project's life are uncertain. NMFS believes the Corps' proposed Columbia River ETM workshop should enhance the understanding of the ETM and its influence on estuary ecosystem function. NMFS expects workshop findings will be discussed within the adaptive management process for the Project. Project modifications will then be implemented, as necessary, to minimize Project-related effects to the ETM.

6.2.2.5 Ecosystem Indicator - Bathymetry (including an analysis of velocity field)

Bathymetric changes will occur in and adjacent to the navigation channel. Dredging will lower the riverbed by three feet, in and adjacent to the navigation channel. Long-term riverbed adjustments will occur on adjacent side slopes (see Section 6.2.2.2, above). Within the riverine areas, 60 percent of the navigation channel will require deepening, whereas only 45 percent of the navigation channel in the estuary reach will require dredging. In-water and shoreline disposal of dredged materials will cause bathymetric changes by raising river and ocean bed elevations at disposal sites.

The deepened navigation channel will result in a small effect (decrease of up to 0.18 feet) on Columbia River water surface elevations in the upper Project area; an essentially immeasurable decrease (0.02 feet) in water surface elevation in the estuary; and no water surface elevation change in the river mouth reach. Of all ESA-listed salmonids, only Columbia River chum salmon spawning habitat occurs in the Project area. However, these water surface elevations should not impact existing habitats (e.g.) spawning and/or rearing, or reduce salmonids' ability to access those habitats.

Water surface elevation reduction would have limited effects on salmonid spawning and survival of eggs in redds upstream of the I-205 Bridge, and minimal impact on juvenile salmonid accessibility to shoreline habitats throughout the Project area. Also, within the upper river portion of the Project, lower water levels may allow marsh progradation (i.e., building out) waterward of the marsh. The OHSU/OGI model evaluated pre-and post-Project water depth differences in terms of hours of habitat opportunity. The model outputs for important, shallow water Cathlamet Bay salmonid habitats, are nearly identical for pre- and post-Project water depths, indicating effects of the proposed action on the water depths will have a limited impact on habitat opportunity.

Changes in bathymetry from dredging and disposal may change river velocity, and thereby affect habitat opportunity. The WES RMA-10 modeling results indicated that average pre- and post-Project velocity differences are small, ranging from approximately -0.2 foot per second to 0.2 foot per second. The largest velocity differences were noted in the navigation channel.

Pre- and post-Project velocity differences in shallow salmonid habitat areas outside the navigation channel ranged from approximately -0.05 to 0.05 foot per second. OHSU/OGI modeling supports these results. The post-Project velocities are well within the range of favorable velocities identified for juvenile salmonids, as defined by NMFS (Bottom et al. 2001). The OHSU/OGI model evaluated pre- and post-Project velocity magnitude differences in terms of hours of habitat opportunity. Modeling results were done for vertically-averaged water column velocities and for minimum and maximum water column velocities. Both the spatial distributions and the area-weighted averages for water column velocity were similar for pre- and post-Project. Maximum differences in average hours of approximately ten to 15 percent (increase and decrease) between base and plan were predicted for model runs at both low and high flow. In these cases, the model runs for the post-Project scenario estimated higher habitat opportunity hours than the environmental baseline.

Based on the impacts to water depth-associated habitat opportunity, NMFS concludes that there will be limited, short-term effects on feeding habitat opportunity or refugia for yearling and older salmonids. In particular, the changes in water surface elevations projected within the estuarine and riverine reaches are not likely to alter the amount or location of refugia. In addition, changes to river current velocity from the proposed dredging are anticipated to be small (particularly in the side channels and shallow water areas that provide the refugia) and will not affect the function of the available refugia. This is because yearlings are commonly found in areas of both low and relatively high current speeds as they rapidly migrate downstream. Generally, yearlings are not strongly shoreline-oriented, although some are found in shoreline areas.

In addition, yearlings tend to be surface-oriented, but feed over a relatively wide range of depths, from the surface up to five to ten meters deep. For subyearling fish, changes in refugia and feeding habitat opportunity may be more pronounced. While short-term impacts appear to be unlikely, the long-term impacts to habitat opportunity and refugia over the Project's life from these limited bathymetric and hydraulic changes cannot be quantified and are therefore uncertain. Any long-term, negative changes in bathymetric or hydraulic conditions may harm these species' aquatic habitat, thereby negatively effecting refugia and habitat opportunity for these species. Therefore any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, are important to monitor and address via the adaptive management process.

6.3 Effects from Construction and Maintenance Activities on Key Salmonid Habitats

During the course of this reinitiation of consultation, much discussion centered around the potential effect of construction and maintenance activities on tidal marsh and swamp, shallow water and flats, and water column habitats. The conceptual model identified these habitat types as particularly important to juvenile salmonids residing in the estuary. Thus, NMFS has focused on these habitat types in its effects analysis. Below is a detailed examination of these three key habitat types, and the Project-related effects to them.

6.3.1 Tidal Marsh and Swamp

Tidal marsh and swamp habitat occurs sporadically along the margins of shallow water areas of the Columbia River and estuary, with these habitats' most concentrated occurrence in the estuary and downstream portions of the riverine reach. Ocean-type chinook and chum salmon commonly use these habitats, and stream-type salmonids also will use these habitats during their shorter occupancy periods.

No dredging within the tidal marsh and swamp habitat is planned. Likewise, no filling of tidal marsh and swamp habitat is proposed as a part of the Project. NMFS, in analyzing potential Project effects to tidal marsh and swamp, focused on the habitat-forming processes of salinity and bathymetry that may affect tidal marshes and swamp habitats.

Based on the WES RMA-10 and OHSU/OGI model outputs, the post-Project salinity distribution is unlikely to change within shallow water estuary areas, where much of the tidal marsh and swamp habitat is located. In addition, even if larger post-Project salinity changes occur in the estuary, the dominant marsh plants found in these habitats exhibit wide salinity tolerances. In upriver areas, tidal marsh and swamp habitats will not be influenced by any post-Project changes to salinity distribution, as these habitat features are upstream of salt water influence.

The other major habitat-forming process that may influence tidal marsh and swamp habitat is bathymetry. Predicted post-Project water surface elevation changes range from zero to -0.18 foot, with the smallest elevation changes predicted in the estuary and lower river areas. In fact, tidal marsh and swamp habitat may increase slightly in upriver Project areas as a result of the channel deepening. The predicted decrease in water surface elevation in upriver areas may provide more shallow water habitat that is at the appropriate depth for tidal marsh to develop. This would allow tidal marshes to establish or expand, and may lead to a long-term, small increase in tidal marsh habitats.

Side-slope adjustments are not expected to occur in natural shoreline areas because these areas are stable, indicating that it is unlikely that tidal marsh and swamp habitat would be affected by post-Project side-slope adjustments. The Corps proposes to monitor for any impacts from side-slope adjustments to riparian habitats, including tidal marsh and swamp habitat. This information will enable the Corps and NMFS to track and react to potential changes in side-slope adjustment.

The following are the two specific environmental indicators that could be affected by changes to tidal marsh and swamp habitats:

6.3.1.1 Insects

Terrestrial insects that form part of the prey base for juvenile salmonids include larval forms, as well as adults. Insect larvae and some adults are often found in the stomachs of salmonids that feed in shallow flats and marsh channels. Salinity intrusion, associated primarily with the main channel, is not expected to change the abundance of insects that are located primarily along the water margins in shallow wetlands and marsh channels.

Short-term impacts to insect abundance and diversity are likely to be limited. Based on Table 7-1 of the 2001 BA, the uncertainty and risk of impact to insect production and salmonid food availability, although potentially limited, is uncertain in the long term. Long-term monitoring, as recommended above for areas of side-slope adjustment, will provide information on Project-related effects to insect production.

6.3.1.2 Macrodetritus and Microdetritus

The production of prey resources important to juvenile salmonids is partially supported by marsh detritus. Resident microdetritus, which is derived from benthic and planktonic algal production, is important to suspension feeders and suspension/deposit feeders. Imported microdetritus is mostly derived from algal production upriver, including that produced above dams. As a primary producer, it is an important food source for suspension feeders and suspension/deposit feeders that form part of the prey base for juvenile salmonids.

The proposed dredging action is not likely to have an effect on the amount or productivity of tidal marsh macrodetritus or microdetritus. This is because no dredging or disposal within the tidal marsh and swamp habitat is planned.

Due to the predicted lowering of water elevation in the upper portion of the Project area, the amount and characteristics of tidal marsh and swamp habitat could result in limited expansion along the shallow water margins of the upper Project area. Increased macrodetritus and microdetritus production may occur from limited marsh expansion upstream of RM 80. Due to the predicted upstream shift of the ETM, there may also be a limited shift in the extent of resident and imported microdetritus food web input. The Project may also result in a small shift in the location of where resident microdetritus dies. Thus, short-term impacts to macrodetritus and microdetritus are likely to be limited. Based on Table 7-1 of the 2001 BA, the risk and uncertainty to this indicator suggests the limited nature of this expansion will have an uncertain benefit to ESA-listed salmonids in the long term.

6.3.1.3 Tidal Marsh and Swamp Summary

NMFS anticipates negative short-term Project-related effects to tidal marsh and swamp habitats will be limited. As described in the SEI risk assessment, long-term Project effects to tidal marsh and swamp habitats are of moderate uncertainty to occur, but have a low risk to impact habitat (see 2001 BA, Table 7-1). Any long-term, negative changes in tidal marsh or swamp habitat may harm ESA-listed species feeding and refugia needs. Therefore, any effects to these habitat conditions above those effects or locations predicted in the 2001 BA will be monitored and addressed over the project life.

6.3.2 Shallow Water and Flats

Shallow water and flats habitats provide important feeding and rearing areas for ocean-type, ESA-listed salmonids. Stream-type juveniles may also potentially use shallow water and flats habitat within the Lower Columbia River and estuary during their shorter occupancy periods. In addition, adult chum salmon use shallow water habitat for spawning in the riverine reach upstream of the I-205 bridge. NMFS, in analyzing potential Project effects to shallow water and flats habitats, focused on Project-related effects from side slope adjustments after channel dredging and after shoreline disposal, and also reviewed Project effects to ecosystem indicators that would respond to changes in shallow water and flats habitat.

The entire post-Project navigation channel may experience side-slope erosion and subsequent adjustment of side-slope angle. The erosion and adjustment will, over five to ten years, lower the adjacent river bed angle until a new, more stable side-slope is established. While side-slope adjustments will occur throughout the Project area in deeper water, where minimal salmonid habitat use is known to occur, some side-slope adjustment will occur in shallow water and flats habitats.

The Corps predicts shoreward erosion from side-slope adjustment to occur in a total of six sandy beach areas: five in the Lower Columbia River (RM 99-86, 75, 72, and 46-42) and one in the estuary (Miller Sands Spit). These areas have shallow water habitats that could be used by salmonids, however, the Corps indicates these are highly erosive areas that have little productivity.

NMFS believes that, even though each of the six sandy beach sites may experience ten to 50 foot lateral erosion into the sandy shoreline, minimal impact to salmonids or their shallow water habitat will occur. As noted in 6.2.2.2, Ecosystem Indicator - Bedload, above, predicted side-slope adjustments will affect habitat for ESA-listed species by alteration of these six areas with shallow water, shoreline habitat. Shallow water habitats provide important feeding and rearing areas for ESA-listed salmonids, therefore any effects to these habitats, above those effects or locations predicted in the 2001 BA, will be monitored and addressed. However, these six shoreline habitats are highly erosive and unstable, and do not provide high quality habitat for these species.

Shoreline disposal could potentially disturb and shift the location of shallow water habitat at three proposed shoreline disposal sites. No salmonids will be injured during shoreline disposal activities, as dredged materials are discharged above the water line. Therefore, NMFS' analysis focused on the potential for disturbing salmonids that use existing shallow water habitat within these areas. The three shoreline disposal locations have steep side slopes (around ten percent) that provide about seven acres per mile of shallow water areas. Shoreline disposal will affect a total of about 4.5 miles or 30 acres of shallow water. While 30 acres of shallow water habitats will be periodically impacted during the project life, the three disposal sites are all highly erosive and do not contain many of the important habitat features that shallow water habitats typically include, such as low velocity, vegetation, and food sources. These sites had previously been approved by NMFS for shoreline disposal because of their low productivity.

The following is the one specific environmental indicator that could be affected by changes to shallow water and flats habitats:

6.3.2.1 Benthic Algae

Benthic algae consist primarily of benthic diatoms that occur on sediment grains and larger inorganic material and on macrophytes as epiphytes.

There will be no dredging in the shallow flats and channels where benthic algae primarily occur. Flowlane disposal is not expected to affect benthic algae because it is done below the depth range where benthic algae occur, about 1 meter below MLLW. No dredging or disposal activities are proposed for areas with significant benthic production. The closest potential effect would be from the shoreline disposal at Sand Island (O-86.2). However, the existing currents and erosion rates at the beach nourishment site create a coarse-grained and erosive environment that severely limits the potential for significant benthic production. Accordingly, no effects to benthic production are anticipated in the riverine reach.

Modeling by OHSU/OGI and WES predicts an upstream shift of salinity of less than a mile. Accordingly, there may be an upstream shift in the location of benthic algae production. Any salinity change would occur primarily in the navigation channel, not in productive side channels or lateral habitats. Thus, short-term impacts to benthic algae are likely to be limited. However, long-term Project-related indirect impacts are uncertain (see Table 7-1 of the 2001 BA). NMFS believes long-term risk to food web production for ESA-listed species, based on changes to benthic algae production, is limited.

6.3.2.2 Shallow Water and Flats Summary

NMFS anticipates that negative short-term Project-related effects to shallow water and flats habitats will be limited to areas of side slope adjustment and shoreline disposal. Long-term Project effects to shallow water and flats habitats are of moderate uncertainty, to occur with low to moderate risk to impact habitat (see 2001 BA, Table 7-1). Any long-term, negative changes in shallow water and flats habitat may harm benthic production, feeding, migration, and refugia needs for ESA-listed species. Therefore any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, will be monitored and addressed through the adaptive management process.

6.3.3 Water Column

The upper portion of water column habitat is used for salmonid movement, migration, and feeding. Deeper water column habitat in the Lower Columbia River, estuary and river mouth is less used by salmonids, with water deeper than 20 feet believed to be rarely used. Water column habitat adjacent to the navigation channel, turning basins, and berths will be directly increased to no more than 48 feet deep. The Project may affect water column habitat by short-term blasting activities, by temporary water clarity reduction during dredging and flowlane disposal activities, and by long-term changes in estuary salinity distribution and ETM range.

Blasting will be done once during Project construction, and will occur only during the in-water work window. Blasting may have direct effects to salmonids, and was discussed in Section 6.2.1 of this Opinion, Direct Effects. Blasting only during the in-water work window minimizes, but does not avoid, direct impacts to ESA-listed species, which may use the Warrior Rock area year-round. As noted in Section 6.2.1 above, Direct Effects, NMFS believes that development of a NMFS-approved monitoring plan, that ensures that the proposed blasting measures are implemented, will be important to minimize any injury or death to these species during blasting activities.

Temporary water clarity reductions will occur from dredging and disposal activities. A proposed impact minimizing action will require all in-water disposal activities, except shoreline and two ecosystem restoration features, to occur below 20 feet in depth, where less salmonid use occurs. Ecosystem restoration features at Miller-Pillar and Lois Island embayment are the ecosystem restoration exceptions to the minimization proposal. As noted in the Turbidity discussion above, these temporary turbidity increases will not decrease plant growth and subsequent habitat forming processes, nor are the Project-related turbidity levels anticipated to impact salmonid physiology or feeding (see 6.2.2.3, above). Project construction and maintenance activities may occur outside of the normal November 1 to February 28 in-water work period. Therefore increased turbidity may occur during periods of highest salmonid abundance in the Project area. Juvenile salmonids occur primarily at depths shallower than 20 feet, and so would not be expected to be impacted by turbidity from dredging and disposal operations. NMFS believes these slight increases to Columbia River and estuary turbidity levels will occur in deeper water areas where the majority of ESA-listed salmonid migration and feeding activities are not occurring. Therefore, the ESA-listed salmonids should experience only limited harassment from increased water column turbidity.

As noted in the ETM and salinity discussions above, the WES RMA-10 and OHSU/OGI models predicted that there was virtually no difference in the habitat opportunity (i.e., salinity “accumulation”) between pre- and post-Project modeling runs for important shallow water Cathlamet Bay salmonid habitats. However, a shift in the location of the ETM would occur and may affect the estuarine distribution of nutrients and thereby the location and abundance of salmonid food in shallow water habitats. The risk and uncertainty to the ETM, based on changes in salinity (Table 7-1 of the 2001 BA), is low in the short term, but more uncertain in the long term because of extrapolating modeling results over the life span of the Project.

The following three specific environmental indicators: deposit feeders, suspension-deposit feeders, and suspension feeders; mobile macroinvertebrates; and phytoplankton could be affected by changes to water column habitats.

6.3.3.1 Deposit Feeders/Suspension-Deposit feeders/Suspension Feeders

Limited removal of organisms via dredging and burying of deposit feeders, suspension/deposit feeders, and suspension feeders will occur in portions of the navigation channel deep water areas and the three shoreline disposal sites. Flowlane disposal will bury some animals and, if deposition of sediments is heavy, will result in the partial loss of some communities. Removal and burial effects are expected to be relatively short-lived, with dredge and disposal areas being recolonized by deposit feeders. Deposit feeders occur in low densities in the navigation channel because the sand waves create constantly shifting habitat conditions. In these and other areas of the river, densities fluctuate as a result of constantly changing environmental conditions. No changes to deposit feeders are anticipated in shallow water areas, side channels, or embayments, which are the important locations for salmonid feeding opportunities. Other than the low risk identified to deposit feeders in the bottom of the navigation channel, Table 7-1 of the 2001 BA suggests that the long-term changes from dredging and disposal to deposit feeders, suspension/deposit feeders, and suspension feeders is uncertain. Because deposit feeders, suspension/deposit feeders, and suspension feeders are prey items for ESA-listed salmonids, any removal of these organisms via dredging or disposal may cause short-term harm to these fish species. However, because the loss of food items is limited, will not occur in the most important habitat types, and these invertebrates recolonize dredge and disposal locations rapidly, NMFS believes the potential for such harm is minimal.

6.3.3.2 Mobile Macroinvertebrates

Dredging will result in removal of mobile macroinvertebrates in the channel. Entrainment by dredges is likely lethal to macroinvertebrates. In addition, flowlane disposal may temporarily bury some animals and, if deposition of sediments is heavy, will result in the loss of some members of the group. Removal and burial effects are expected to be relatively short-lived, with dredged areas being recolonized within six to 12 months (Flemmer, et al., 1997). Mobile macroinvertebrates located in shallow water, flats, and tidal marsh channels are not likely be affected. ESA-listed salmonids may feed on certain mobile macroinvertebrates, and therefore any loss of these prey items via dredging or disposal may harm these species. However, NMFS anticipates this harm from dredging or disposal to be localized to areas of low importance to these species.

Mobile macroinvertebrates in the estuary appear to be adapted to respond rapidly to disturbances and can recolonize areas following these disturbances. Due to this group's wide salinity tolerance, Project-related changes in estuary salinity are not expected to have an effect on the distribution of mobile macroinvertebrates. In addition, since Project-related temperature and suspended sediment changes are not anticipated or will be limited in nature, mobile macroinvertebrates should not be influenced by limited Project-related changes to these indicators.

6.3.3.3 Phytoplankton

Because salinity may intrude farther into the estuary as a result of the deeper channel depth, the point where imported phytoplankton contact dilute seawater will be farther upstream from current conditions. Predicted changes in salinity intrusion may affect the location of resident phytoplankton productivity. Based on Table 1 of the 2001 BA, the short-term impacts to imported and resident phytoplankton productivity changes are likely to be limited, and will not harm ESA-listed species. However, long-term impacts over the Project's life, based on the BRT's risk and uncertainty analysis, are uncertain.

6.3.3.4 Water Column Summary

NMFS anticipates that negative, short-term Project-related effects to water column habitats will be limited to blasting areas and areas where in-water disposal is occurring, and to ecosystem indicators associated with inwater disposal. NMFS believes that development of a NMFS-approved monitoring plan that ensures that the proposed blasting measures are implemented, will be important to minimize any injury or death of ESA-listed salmonids during blasting activities. NMFS believes that only limited harassment from increased water column turbidity will occur to ESA-listed salmonids. Removal of deposit feeders, suspension/deposit feeders, suspension feeders, and mobile macroinvertebrates via dredging or disposal activities may cause short-term harm to ESA-listed salmonids. Long-term Project effects to water column habitats are of moderate uncertainty, with low risk to adverse habitat modification (see 2001 BA, Table 7-1). Any long-term, negative changes in water column habitat may harm feeding, migration, and refugia needs of ESA-listed salmonids. Therefore any effects to these habitat conditions, above those effects or locations predicted in the 2001 BA, are important to monitor and address via the adaptive management process.

6.4 Indicators that Occur in More Than One Key Habitat Type

6.4.1 Habitat Complexity, Connectivity, and Conveyance; Feeding Habitat Opportunity; Refugia; and Habitat-specific Food Availability

In discussion associated with this consultation, consideration was given to whether the proposed Project has the potential, based on post-Project changes in water surface elevation, velocity, and salinity intrusion, to change habitat complexity, connectivity, or conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability associated with tidal marsh and swamps and shallow water and flats habitat areas. These are indicators that may respond to Project-related changes in any of the key habitat types, and therefore reflect an ecosystem approach to impact assessment.

The Corps undertook modeling to examine the potential Project effects on habitat opportunity and key habitat types from changes in water surface elevation, velocity, and salinity intrusion. The OHSU/OGI and WES RMA-10 modeling results indicate slight changes to water surface elevation, velocity, and salinity intrusion. Within Cathlamet and Grays Bays' tidal marsh and swamps and shallow water and flats habitat habitats, modeling predicted post-Project salinity increases of 0.1 to 0.15 ppt, velocity decreases of 0.05 feet per second, and depth changes of less than 0.02 feet. Habitat opportunity, based on a combined analysis of these indicators, shows no significant difference between pre- and post-Project conditions in tidal marsh and swamps and shallow water and flats habitats. The OHSU/OGI modeling also related these physical parameters to the concept of habitat opportunity (see Bottom et al., 2001). In the modeling example provided by OHSU/OGI, navigation channel improvements are predicted to result in a limited change in habitat opportunity hours for Cathlamet and Grays Bays, based on the depth and velocity criterion and salinity "accumulation."

The two indicators most related to habitat opportunity are feeding habitat opportunity and refugia (see Chapter 5 of the 2001 BA). Additional indicators related to habitat opportunity are habitat complexity, connectivity, and conveyance, and habitat-specific food availability. Based on the limited impacts indicated by the OHSU/OGI habitat opportunity modeling results, NMFS believes the Project will have limited short-term effects on tidal marsh and swamps and shallow water and flats habitat habitats. Limited effects to these key habitats should result in limited effects to associated habitat complexity, connectivity, and conveyance; feeding habitat opportunity; habitat-specific food availability; and refugia for ESA-listed salmonids. NMFS anticipates limited harm to ESA-listed salmonids from changes to habitat opportunity and associated indicators.

Model-generated estimates of habitat opportunity provide an indication of limited change to depth, velocity, and salinity within key habitat types (tidal marsh and swamps and shallow water and flats habitat habitats), but do not predict response by key habitat or other related indicators' to Project-related changes in depth, velocity, and salinity over the long term. This fact, combined with the risk and uncertainty indications provided in Table 7-1 of the 2001 BA for habitat opportunity-related indicators, suggest that the long-term impact to these indicators is uncertain. NMFS believes any effects to these habitat conditions, above those effects predicted by modeling or presented in the 2001 BA, are therefore important to monitor over longer time scales and address via adaptive management.

6.4.2 Contaminants

Dredging and in-water disposal activities in the navigation channel turning basins and berths, and in-water disposal activities in the ocean, along with other natural and anthropogenic processes, could expose salmonids to some contaminants. Of particular concern is resuspension of persistent organochlorine contaminants including total polychlorinated biphenyls (PCBs) and the pesticide DDT and its metabolites DDE and DDD (? DDTs), which have bioaccumulated in resident fish and wildlife within the estuary (see terrestrial species Opinion for further description of these concerns). In addition, petroleum compounds, characterized as total polyaromatic hydrocarbons (PAHs), have been identified in Lower Columbia River sediments. The organochlorine and PAH contaminants have the ability to impact growth, survival, and reproduction of juvenile salmon and trout, and can cause sublethal effects such as immune dysfunction (Arkoosh et al. 1991; also see

2001 BA, Appendix B for further discussion of lethal and sublethal impacts of these chemicals on salmonids). Data collected by NMFS indicate that juvenile salmonids within the Columbia River estuary have contaminant body burdens that may already be within the range where sublethal effects may occur, although the sources of exposure are not clear (NWFSC Environmental Conservation Division, 2001).

Data are sparse regarding the exact pathways for uptake and bioacumulation of contaminants by juvenile salmonids in the Lower Columbia River, or the relationships between sediment and tissue contamination (see 2001 BA Appendix B for identification of specific pathways for salmonids). Recent studies suggest that sediments are a major source of hydrophobic contaminants to aquatic biota (Zaranko et al., 1997, Maruya and Lee, 1998). In sediments, contaminants are adsorbed to the organic carbon in silt, which is part of the fine particulate fraction. The microbial biofilm that accumulates on the surface of organic particles constitutes the food of certain types of epibenthic invertebrates; together, they make up the pathway by which these contaminants enter food chains involving juvenile salmonids. Thus, juvenile salmonids bioaccumulate organochlorine contaminants and PAHs principally from their food (i.e., epibenthic prey species) as opposed to water. NMFS has documented some contaminants in the epibenthic prey species of juvenile salmonids in the Lower Columbia River (NWFSC Environmental Conservation Division, 2001).

In order to adequately address the potential contaminant-related impacts from Project activities, it is important to assess the amount of fine-grained (and thereby potentially-contaminated) material retained in the estuary following dredging and disposal activities. According to the 2001 BA, the Columbia River navigation channel is dominated by course-grained materials (primarily sand) with very low organic carbon, although pockets of fine materials are occasionally encountered, such as within the turning basin at Astoria, Oregon. The navigation channel is characterized by sand waves along the riverbed that move downstream. As the downstream sand movement occurs, bedload transport erodes sand from the upstream face, deposits in the downstream trough, and then buries it with more sand eroded from the upstream face. This transport occurs in a layer only a few sand grains thick. The sand that forms the cutline shoals or sand waves is repeatedly re-exposed to the water column. Consequently, fine material mixed in with the sand is likely to be swept away as the layers are exposed to the river currents, resulting in the limited potential for release of fines during the dredging activity. The Corps employed a risk-based analysis (see Appendix B of the 2001 BA) to address the potential resuspension of contaminants (total PCBs, ? DDTs, and total PAHs) produced by Project construction and maintenance activities. The results of the Corps' assessment concluded that contaminant concentrations in the navigation channel sediments posed only negligible risk to juvenile salmonids, whereas some nearshore sediments closest to point sources of contamination posed risks.

It is important to ensure that sufficient sediment samples are available to adequately characterize the nearshore and channel sediment. During their Sediment Quality Evaluation for the Project, the Corps reported 3 of 23 samples chemically analyzed within or near the navigation channel contained fine-grained sediments with detectable levels of DDT, DDE, DDD, and total PCBs. However, none of these samples exceeded DMEF or NMFS recommended contaminants thresholds. These data and other sediment data were evaluated in the risk assessment for salmonids (see Appendix B of the 2001 BA), which concluded that sediments from the navigation channel pose negligible risks to salmonids. However, this Appendix B conclusion was based on relatively few sediment samples collected within the navigation channel, especially below RM 40. The Corps has subsequently submitted additional analysis of all available sediment and contaminants data from the Columbia River navigation channel (Corps' April 22, 2002 addendum). The Corps has determined there are no navigation channel sediment and contaminants data which exceed current DMEF contaminants thresholds. These additional data also do not exceed NMFS' thresholds for PCB's (75 ng/g dry weight for 1% total organic carbon [TOC]) and PAH's (1,000 ng/g dry weight sediment) (NMFS' contaminants thresholds provided by Johnson, NMFS Northwest Fisheries Science Center, 2002).

Due to the highly erosive and dynamic nature of the navigation channel, described above, and based on the Corps' risk analysis results and information provided in the Addendum to the 2001 BA, NMFS believes it unlikely that any contaminants within the navigation channel would be present in high enough concentrations to expose and impact ESA-listed salmonids and bull trout. However, it is unknown how much fine material will be resuspended during Project dredging and disposal activities, or whether or not any of the fine material released would be contaminated. The general lack of organic material and very low organic carbon concentrations in the navigation channel sediments would likely result in rapid transfer of any available carbon and contaminants into salmonid tissues. Even low concentrations of bioaccumulative contaminates would be readily available to salmonids in this situation, and predators higher in the food chain, such as bald eagle, could be more at risk than salmonids. Therefore, NMFS believes additional navigation channel samples should be periodically collected, and all other new sediment quality data evaluated, on a regular basis during Project activities to better determine the distribution of fine materials, carbon, or contaminants within the navigation channel.

In summary, NMFS believes that dredging and inwater disposal activities associated with the Project could release a small amount of fine-grained sediments. It is uncertain as to whether most of these fine-grained sediments would be uncontaminated (due to the erosional forces within the main channel of the river), or if some of the fine-grained material would be associated with contaminants. In the high-energy environment of the navigation channel, any contaminated material would move rapidly through the system and be deposited outside the flow lane in depositional areas within the estuary, or be transported down the flow lane and into the ocean. Any contaminants that did reach riverine and estuarine depositional areas, combined with contaminants transported and deposited due to natural and other non-Project anthropogenic sources, would eventually be redistributed, resuspended, and transferred along the estuary and river food chain.

The contribution of Project activities to contaminant burdens in salmonids is not well defined and, as such, some uncertainty exists as to Project effects to ESA-listed salmonids and bull trout. NMFS therefore supports implementation of the Corps' contaminants research activities ERA-4 and ERA-5, proposed in the 2001 BA (see Table 8-1) and monitoring action MA-5, proposed in the 2001 BA (see Table 7-3). However, the Service believes estimated risk of exposure of ESA-listed salmonids and bull trout from contaminated sediments from Project activities appears limited (see Appendix B of the 2001 BA).

6.5 Effects from Interrelated and Interdependent Activities

Willamette River Navigation Channel Deepening

More than 11 miles of the Willamette River are included in the Project authorized by Congress but are not analyzed in the 2001 BA or this Opinion. Concerns over Willamette River sediment contamination and uncertainty regarding the scope and timing of remedial investigations and actions caused the Corps to remove this portion from the proposed action. Potential effects from any future Willamette River Navigation Channel deepening activity cannot be determined, due to the unknown implications of Superfund cleanup and other remedial actions. If the Corps is to proceed with a Willamette River navigation channel deepening project in the future, the Corps will be required to review the additional effects of this future Federal action through a separate ESA consultation process.

Deepening and Maintenance of Project Berths

Construction and maintenance dredging at a total of seven Lower Columbia River berths, associated with three grain facilities, one gypsum plant, and one container terminal, represent actions that are interrelated and/or interdependent to the Project. However, this Opinion does not provide incidental take coverage for berth dredging, as these activities will undergo future ESA consultation. The future ESA consultation will initiate upon NMFS' receipt of applications for Federal permits, prior to berth-dredging activities.

Future berth deepening and maintenance activities are likely to have both direct and indirect impacts on listed-ESA salmonids. Direct effects include death or injury due to entrainment during dredging activities. Indirect effects include harm and harassment to ESA-listed salmonids via increased turbidity, loss of food resources, and resuspension of toxic sediments.

Effects from future berth deepening activities will be minimized due to application of dredging and disposal BMPs and other compliance measures (see Table 3.2 of this Opinion). Sediment testing, based on DMEF protocols, will ensure dredged materials from berths are disposed in the least impactful method. Additional sediment testing may be required, during additional consultations (see discussion of MA-5 in Section 3.2.6 of this Opinion). Dredging activities will occur within the November 1 to February 28 inwater timing window, when ESA-listed salmonid abundance is lowest. Dredge activities will occur in deep water, where food resources are limited and most salmonids are not present. Finally, higher quality habitat, associated with key habitat types in the ecosystem conceptual model, are not believed to occur at these existing berth features, and therefore impacts to these habitats will be avoided.

NMFS believes berth deepening and maintenance will have limited future adverse effects on ESA-listed salmonids. While some of these adverse effects can be successfully minimized by application of BMP's and compliance measures, a limited amount of harm and harassment of ESA-listed salmonids is likely to occur from berth deepening and maintenance activities. These berth deepening and maintenance activities will undergo future ESA analysis prior to berth dredging activities to address this incidental take of ESA-listed salmonids.

Development of Port Activities and Deep Draft Vessels

Based on the Corps' 1999 FEIS analysis, future development of other Lower Columbia River port facilities is not analyzed here as an interrelated or interdependent activity because such development will be caused by regional market factors such as commodity demand, not by channel improvements. The Corps' April 15, 2002, addendum further supports the Corps' FEIS conclusion that, aside from berth deepening, potential future port development is not interrelated or interdependent with the Project.

Impacts from interdependent ship wakes would occur only if the Project resulted in more frequent or larger, higher-energy ship wakes. Current impacts from shallow- and deep-draft ship traffic utilizing the 40 foot navigation channel are considered part of the environmental baseline and are not considered interrelated or interdependent to the Project; only future, Project-dependent ship traffic is considered in this analysis.

The Corps analysis of post-Project ship wake effects indicated that larger, fully-loaded ships would have a 1 to 5 percent increase in "blockage ratio" (indicative of slightly higher ship wake generation), whereas smaller vessels would have a 1 to 5 percent decrease in "blockage ratio" (indicative of slightly lower ship wake generation). NMFS concludes that these limited increases and decreases in post-Project ship wake are not likely to increase suspended sediment, shoreline erosion, or increase current rates of ship wake-induced salmonid stranding.

In summary, the Corps concluded in their 1999 FEIS that channel deepening will not induce additional ship traffic, or contribute to development of additional port infrastructure or new ports. This conclusion is consistent with historical vessel traffic trends on the Columbia River and with the market forces that drive port facility development.

Non-indigenous Species Introductions

Several non-indigenous aquatic species are believed to have been introduced into the Columbia River via ballast discharge (e.g., Asian clam). These non-indigenous species introductions may continue to occur from ongoing vessel traffic, regardless of the Project's deepened channel. Future deep-draft cargo vessel traffic, interrelated and/or interdependent to the deepened navigation channel, also may introduce additional non-indigenous species. Federal authority for management and regulation of exotic species via ship ballast resides with the U.S. Coast Guard. While NMFS believes additional non-indigenous species introductions could have detrimental impacts on Columbia River and estuary ecosystem resources, NMFS does not believe that new boat traffic, interrelated and/or interdependent to the deepened navigation channel, will increase the risk of introduced species above current baseline levels.

If new information is identified which changes the assumptions and/or conclusions of the 1999 FEIS or 2001 BA regarding the potential for future interrelated and interdependent Project actions, the Corps will need to reinitiate Project consultation to address those activities. Additionally, no other non-Project activities within the

Lower Columbia River, estuary or river mouth have been reviewed in this effects analysis. Therefore, any additional actions to deepen or otherwise improve adjacent port facilities not addressed in this Project consultation and conference, would be subject to separate environmental analysis and regulatory review.

6.6 Uncertainty Regarding Project-related Effects and Associated Risk to Ecosystem Indicators as Related to Monitoring Actions

The SEI panel suggested that scientific and management decisions involve a level of uncertainty related to environmental effects and associated risk to the ecosystem from those environmental effects. Uncertainty pertains to the amount of information available to predict a Project-related change to an indicator. For instance, if ample information for an indicator was available, the uncertainty associated with that indicator, in regards to potential Project effects, would be low.

For the purposes of this reinitiation of consultation, risk pertains to the level of threat to the health or survival ESA-listed salmonids from Project-related changes to indicators. For instance, if salmonids are extremely sensitive to small changes in an indicator, then the risk associated with any Project-related changes to that indicator would be high. For purposes of the reinitiation process, including BRT analysis and deliberations, each conceptual model indicator was evaluated to determine uncertainties and risk from implementing the proposed Project activities. That information is included in the 2001 BA (see Section 7.2), and is incorporated herein by reference.

As noted above in Sections 6.2.2 - 6.5 of this Opinion, NMFS believes that Project-related indirect effects to ecosystem indicators will be limited. Key physical processes that likely will have limited changes during the channel construction process include suspended sediment, accretion/erosion, turbidity, salinity, bathymetry, and bedload. The short-term nature of these impacts was discussed during the SEI panel process and verified using the numerical modeling conducted by WES and OHSU/OGI. It should be noted that the levels of Project risk to ecosystem indicators were not high enough to require Project modification, but due to long-term uncertainties, were still of a level that warrants verification through monitoring.

Based on uncertainties regarding potential long-term Project effects and associated risk to salmonids, the Corps proposed a monitoring program (see Table 3.5, and Section 3.1.6 of this Opinion). NMFS reviewed and commented on the monitoring program as it was developed during the BRT process. The monitoring program addresses the long-term ecosystem uncertainties and risk to the main ecosystem indicators and key habitat features (Table 6.1) addressed in Section 6.2 - 6.7. Monitoring results will be reviewed, and future changes to management will occur if adverse findings are determined.

Table 6.1 Pathways and Indicators to be Addressed by the Monitoring Program

Monitoring Action	Pathway	Indicators
Maintain three hydraulic monitoring stations to investigate pre- and post-Project relationships among flow, tide, salinity, water surface, and water temperature	Habitat-forming processes	Bedload; Salinity
	Growth	Habitat complexity, connectivity, and conveyance; Velocity Field; Feeding Habitat Opportunity
Compare actual to predicted sediment dredge volume	Habitat-forming processes	Bedload
Complete bathymetric surveys to track habitat alterations	Habitat-forming processes	Accretion/Erosion; Bathymetry
	Key Habitat Types	Shallow water/flats habitat
Aerial and ground mapping to track habitat alterations	Key Habitat Types	Tidal marsh and swamp habitat
	Food Web	Suspension/deposit feeders; Insects; Tidal marsh macrodetritus
	Growth	Refugia; Habitat-specific food availability
Review sampling needs for contaminants	Survival	Contaminants
Investigate pre- and post-Project salmonid stranding events	Survival	Stranding

6.7 Effects Resulting from Proposed Monitoring, Ecosystem Restoration, and Research Activities

The BRT identified the monitoring, research and ecosystem restoration components of the proposed action to verify assumptions, reduce scientific uncertainties and provide for long-term beneficial effects to ESA-listed salmonids and their important habitats. Substantial scientific information suggests that certain habitat types play a major role in the long-term viability of salmonid populations, including tidal marsh and swamp habitats, shallow water and flats habitats, and water column habitats. The Corps has therefore identified a number of restoration actions that have a high probability of enhancing the availability and productivity of these habitats for migrating salmonids through the action area. Nevertheless, the implementation of these restoration actions and the implementation of the monitoring and research actions will likely have short-term detrimental impacts of limited scope and duration.

This section reviews the effects of these components of the proposed action on ESA-listed salmonids. NMFS notes the difficultly of quantifying effects to ESA-listed salmonids from monitoring, research, and restoration actions, based upon available information, and further notes that much of the scientific emphasis during this reinitiation of consultation focused upon the effects of the navigation project upon habitat indicators and habitat forming processes that may be of significance to ESA-listed salmonids. The modeling efforts did not seek to directly quantify the long-term effects of these restoration or research activities on habitats of importance to ESA-listed salmonids. Hence, the effects analyses associated with these monitoring, restoration, and research activities are necessarily of a different and more qualitative nature than those associated with the navigation improvements.

6.7.1 Monitoring Program

Section 3.2.6 of this Opinion describes the elements of the comprehensive monitoring program that is part of the proposed action. Table 3.5 enumerates objectives of each element of the monitoring and their relation to the assumptions or predictions associated with this consultation. In Table 6.2, below, NMFS describes the anticipated effects of these monitoring activities. NMFS concludes that the adverse effects of implementing a monitoring program are likely to be limited, and will not cause take of ESA-listed salmonids.

Table 6.2 Proposed Project Monitoring Activities and Effects of Monitoring Program Implementation

Monitoring Activity	Anticipated Effects of Monitoring Program to Salmonids
Maintain three hydraulic monitoring stations: One downstream of Astoria, one in Grays Bay, and one in Cathlamet Bay. Parameters measured would include salinity, water surface elevation, and water temperature.	Over-water access to maintain monitoring stations should have minimal impacts to salmonids and their habitats.
Monitor annual dredging volumes from both construction and O&M activities.	None
Conduct main channel bathymetric surveys throughout Project area.	Over-water access to conduct bathymetric surveys should have minimal impacts to salmonids and their habitats.
Repeat estuary habitat surveys being conducted by NMFS.	Over-water and aerial access to conduct habitat surveys should have minimal impacts to salmonids and their habitats.
Review the SEDQUAL database and other available data to determine if there are areas that would require additional sampling. Review existing contaminants database using NMFS guidelines or trigger values that are more protective of salmonids and trout. Provide notification during construction dredging to monitor for presence of fine-grained material – i.e., oily sheens.	Over-water access to conduct additional sediment surveys, and substrate-disturbing activities associated with additional surveys should have minimal impacts to salmonids and their habitats.
Monitor the incidence of stranding of juvenile salmon on beaches in action area. Field surveys will be made monthly at selected beaches (upper, mid, and lower river) during the April-August out-migration to measure the number of fish being stranded along beaches.	Over-water access to conduct salmonid stranding surveys should have minimal impacts to salmonids and their habitats. Handling of stranded salmonids is anticipated. Procedures for salvaging ESA-listed salmonids are provided in this Opinion's Incidental Take Statement.

6.7.2 Ecosystem Restoration Activities

The Corps proposed several ecosystem restoration activities to create or improve salmonid habitat, specifically tidal marsh/swamp and shallow water/flats habitat. It is important to emphasize that the ecosystem restoration projects identified below are not being proposed as Project "mitigation." These are restoration activities being proposed under Section 7(a)(1) of the ESA to benefit the conservation of ESA-listed salmonids

Six of the seven new restoration features proposed by the Corps (Lois Island Embayment Habitat Restoration, Purple Loosestrife Control, Miller/Pillar Habitat Restoration, Tenasillahe Island Interim and Long-term Restoration, and Bachelor Slough Restoration) occur in-water and have the potential, during implementation, to affect ESA-listed salmonids. The translocation of Columbian white-tailed deer to Cottonwood/Howard Island will have no effect on ESA-listed salmonids as the action is upland in nature. Two of the three original restoration actions identified in the FEIS (Columbia River Tidegate Retrofits and Walker-Lord and Hump-Fisher Islands Channel Connectivity Enhancements) occur in-water, so they also have the potential to affect ESA-listed salmonids. Other original FEIS restoration actions (e.g. Shillapoo Lake) are disconnected from ESA-listed salmonid habitats and will not have either beneficial or detrimental effects to ESA-listed salmonids. Section 8. of the 2001 BA and Chapter 4 of the Corps 1999 FEIS describe the proposed restoration activities and their effects on ESA-listed salmonids. Both descriptions are incorporated here by reference.

6.7.2.1 Lois Island Embayment

Construction actions for the Lois Bay embayment restoration feature may result in temporary impacts to ESA-listed salmonids. Materials to be placed in the embayment are primarily clean, medium-grained sands that meet the guidelines for in-water placement in accordance with the DMEF. Consequently, transfer of contaminated sediments is avoided, and the turbidity plume associated with discharge into the restoration site is expected to be limited.

However, since several dredge and fill events at the temporary sump and Lois Island restoration sites will occur, there are opportunities for benthic organisms, other salmonid prey items, and ESA-listed salmonids to be affected during dredging and disposal. These actions may cause direct taking of a limited number of ESA-listed salmonids via death and injury from material disposal in shallow water Lois Island embayment habitats and deeper water temporary sump habitat, harm to ESA-listed salmonids via loss of prey items, and harassment of ESA-listed salmonids via the turbidity plume. The Service believes these effects should be limited to the sediment storage site and restoration site and will be very short in duration. In addition, placement of sediments into the Lois Island embayment will be restricted to the November 1 to February 28 in-water work window, to minimize impacts to ESA-listed salmonids. Recolonization of the restored embayment by plants will take five to ten years or more, depending on the species and their means of colonization. The tidal marsh fringing the embayment and the large expanses of tidal marsh in Cathlamet Bay represent a large source of plant propagules for the restoration site. Similarly, benthic organisms are abundant in Cathlamet Bay and represent an excellent source population for rapid recolonization of the embayment. Benthic productivity and related use by salmonids may be less for an undetermined interim period as populations reestablish and densities increase. The proposed restoration feature will be beneficial to ESA-listed salmonids in the long term because, as tidal marsh habitats recolonize, primary (plant) and benthic productivity should approach historical levels. The proposed restoration feature would benefit ESA-listed salmonids by improving habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability.

6.7.2.2 Purple Loosestrife Control

The ecosystem restoration activity for purple loosestrife control would include an integrated pest management approach using biological agents, herbicides, and mechanical control measures. These actions would typically occur in the upper elevations of tidal marsh habitat and have a limited likelihood of adversely affecting ESA-listed salmonids, directly or indirectly.

Rodeo®, an EPA-registered chemical approved for over-water application, would be used in conjunction with biological agents and mechanical control measures. The Rodeo® formulation is comprised of glyphosate (53.5%) and water (46.5%) as the carrier agent. Glyphosate is slightly toxic to fish and practically non-toxic to aquatic invertebrates. Rodeo® bioaccumulation in fish does not occur. The glyphosate formulation (Rodeo®) proposed for use under this action, was selected for its low relative toxicity compared to other available formulations. By comparison, the LC_{50} of Roundup® (glyphosate + EntryII® surfactant) to fish is 5 to 26 mg/l and the LC_{50} of R-11® (a common surfactant used with glyphosate) to fish is 3.8 mg/l.

Glyphosate is also strongly adsorbed by soil and does not retain herbicidal properties following contact with soil. The half-life of glyphosate in soil can range from 3 to 249 days. In general, studies have indicated that glyphosate degradation is fastest in soils of fine texture and high organic content and slowest in coarse textured soils with low organic content. Glyphosate degradation in soils of the project area would be expected to be slow due to the fine to medium grain sand with low organic content found throughout areas of the proposed ecosystem restoration project. The main break-down product of glyphosate is aminomethylphosphonic acid, which is further broken down by soil microorganisms.

Because glyphosate is strongly absorbed by soil particles, it is not easily released back into water moving through soil. Thus within the ecosystem project area, any glyphosate that may reach the water is expected to degrade over-time. Tests show that the half-life for glyphosate in water ranges from 35 to 63 days.

Rodeo® application may result in the short-term, very limited loss of some native vegetation, and will create openings in marsh habitat where non-native plants previously existed. The herbicide will be wicked or spot-sprayed on to purple loosestrife by hand, thereby limiting chemical contact with water. Wicking also lessens the potential for impacts to native vegetation. Mechanical control (pulling) would only affect a small area at any given time, typically during lower tidal stages.

By helping to eradicate purple loosestrife in the Columbia River estuary and thereby reestablish the diverse native vegetation of tidal marsh habitats, this restoration feature is likely to benefit ESA-listed salmonids. These changes should benefit habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia, and habitat-specific food availability.

6.7.2.3 Miller/Pillar Habitat Creation

Construction actions for the Miller/Pillar habitat creation may result in temporary impacts to ESA-listed salmonids. Construction of this restoration action may result in the temporary displacement of juvenile salmonids from the immediate area of the discharge pipe and the pile dike construction location, and temporary loss of benthic prey items.

Materials to be used for habitat creation are primarily clean, medium-grained sands that meet the guidelines for in-water placement in accordance with the DMEF. Consequently, transfer of contaminated sediments is avoided, and the turbidity plume associated with discharge into the restoration site is expected to be limited.

These actions may cause direct taking of a limited number of ESA-listed salmonids via death and injury from material disposal in shallow water habitats, harm to ESA-listed salmonids via loss of prey items, and harassment of ESA-listed salmonids via the turbidity plume. NMFS believes these effects should be limited to the restoration site and will be very short in duration.

Once construction is completed, future potential disturbance actions would be limited to maintenance of the new pile dikes, an intermittent effort over many years. Pilings and spreaders would be fitted with bird excluders to minimize or eliminate use by double-crested cormorants. A previous study has established that driving of wood piles with an impact hammer does not produce shounds that are in the hearing range of salmonids (Carlson et al., 2001).

The construction and maintenance of this restoration action, for the short term, are likely to adversely affect salmonids shallow water and water column habitat, and temporarily remove some food resources, but will benefit ESA proposed and listed salmonids by providing more productive habitats for benthic invertebrates and thus juvenile salmonids as well. This habitat restoration feature should result in improvements to habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability.

6.7.2.4 Tenasillahe Island Tidegate and Inlet Modifications

This ecosystem restoration feature will improve both habitat connectivity and water quality of interior channels. Juvenile salmonids should be able to access additional acres of productive tidal marsh and swamp habitat for rearing and foraging. Construction impacts from tidegate installation and inlet modification are anticipated to be of short duration (a few days to two weeks). However, since in-water work would be required, some limited-duration harassment of ESA-listed salmonids from the turbidity plume may occur. Through appropriate timing, impacts to juvenile salmonids in the immediate construction area can be further minimized. NMFS anticipates that this action will benefit ESA-listed salmonids by opening up access to productive rearing and refuge areas that are not now accessible to juvenile salmonids. This action will result in improvements to water quality, habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability.

6.7.2.5 Tenasillahe Island Historical Habitat Restoration

Long-term Tenasillahe Island restoration activities will only occur if Columbian white-tailed deer are delisted and the eventual long-term Tenasillahe Island restoration plan is consistent with the Julia Butler Hansen National Wildlife Refuge's purpose and goals. This restoration action will be developed in the future, and therefore would undergo site-specific section 7 ESA consultation when fully designed. Conceptually, NMFS believes that should this project be undertaken, numerous ecosystem indicators would be benefitted, including tidal marsh and swamp habitat, and all pathways associated with habitat primary productivity, food web, salmonid growth, and salmonid survival.

6.7.2.6 Bachelor Slough

This project is designed to increase river flows traveling through the slough, with associated improvements in water quality and connectivity. Juvenile salmonids would be more likely to be drawn into Bachelor Slough under these changed conditions during the outmigration. Cooler temperatures would be beneficial to fish drawn into Bachelor Slough. Additionally, six acres of riparian habitat would be restored along the Bachelor Slough shoreline, plus additional riparian forest habitat would be developed on the disposal areas associated with this activity.

Dredging would occur between July 1 and September 15, to avoid periods when juvenile salmonids are most abundant. All disposal materials would be placed on exisitng disposal sites or upland areas. Disposal of material dredged from Bachelor Slough provides an opportunity to develop riparian forest. Riparian forest restoration would provide for detrital and insect export to the Columbia River. Permanent riparian forest habitat would provide for export of large woody debris to the Columbia River and its estuary over the long term.

Bachelor Slough sediment quality would be evaluated prior to implementation of the restoration feature to ensure dredge-released contaminants would not occur. The project would be modified if contaminants were determined to be outside established regulatory parameters for upland disposal. Timing restrictions for pipeline dredging will minimize impacts to salmonids from dredging operations. Due to the project timing and the current, low quality salmonid habitat in Bachelor Slough, NMFS does not believe this project will have adverse effects on ESA-listed salmonids.

6.7.2.7 Columbia River Tidegate Retrofits

The Corps has proposed to retrofit the tidegates on five tributaries to the Columbia River, and to conduct additional tidegate retrofit activities on other tributaries in the future. The Oregon tributaries include Tide Creek, Grizzley Slough and Fertile Valley Creek, and the two Washington tributaries include Burris Creek and Deep River. Further information on these proposals is located in Chapter 8.4 of the 2001 BA, in the 2001 BA addendum, and Chapter 4 of the Corps 1999 FEIS. That information is incorporated here by reference. Construction actions are of short duration (e.g., less than one week per structure) and soil disturbance, thus turbidity, would typically be limited in nature. If the entire tide gate and associated culvert require replacement, temporary coffer dams would be placed on each end of the culvert to preclude sediment impacts to the stream. However, since inwater work would be required, some limited duration harassment from the turbidity plume may occur to ESA-listed salmonids.

The tidegate retrofit restoration feature is estimated to provide or improve anadromous fish access to 38 miles of tributary streams. These tributaries contain spawning, stream rearing, and (near their confluence with either the Columbia River or a more major tributary) backwater channel and freshwater marsh habit for rearing and/or overwinter refuge from floods. Additionally, the Corps would replace additional tidegates, if additional tidegate retrofit projects were identified. This action should result in short- and long-term improvements to habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia, and habitat-specific food availability by reconnecting the Columbia River to these tributary streams.

6.7.2.8 Walker/Lord and Hump/Fisher Islands Channel Connectivity Enhancements

The purpose of this restoration action is to improve water flow and circulation through this island complex, thereby lowering embayment temperatures and creating a network of channels. This feature should increase habitat connectivity and improve foraging conditions for juvenile salmonids. Construction activities are primarily upland in nature and involve construction of a channel in a historical dredged material deposition area. A brief period of in-water construction would occur when the channels at the embayment and river are opened. Given the short duration of the construction action and the fact that material to be excavated is primarily medium-grained sand, turbidity in adjacent waters should be of short duration and extent. Construction timing would typically be late summer to take advantage of lower water levels, dry soil conditions, and the general absence of fish. As a result, the potential for short-term adverse impacts to salmonids would be minimized. Due to timing and location of the inwater action, NMFS does not believe the restoration action will take ESA-listed salmonids. This restoration will provide some short- and long-term improvements to habitat complexity, connectivity, or conveyance; feeding habitat opportunity; refugia; and habitat-specific food availability indicators.

6.7.2.9 Martin Island Embayment Modification

The objective of this wildlife mitigation action is to create tidal marsh habitat, which would increase detrital export to the Columbia River. The Project may have some adverse effect on the aquatic environment, including smothering of plants, algae, invertebrates, and potentially salmonids. These actions may cause limited taking of ESA-listed salmonids via death and injury from material disposal in shallow water habitats, harm to ESA-listed salmonids via loss of prey items, and harassment of ESA-listed salmonids via the turbidity plume. NMFS believes these effects should be limited to the restoration site and will be very short in duration. Construction placement of dredged material and topsoil will temporarily increase turbidity, although a barrier placed at the inlet will minimize turbidity export to the adjacent side channel. However, the material to be placed into the embayment is primarily clean, medium-grained sand from the navigation channel, which would minimize impacts from turbidity and avoid bioaccumulation of contaminants. In the long term, the project would benefit benthic invertebrates, including those species that are used as forage resources by juvenile salmonids, and improve habitat complexity, connectivity, or conveyance, feeding habitat opportunity, refugia and habitat-specific food availability. In addition, development of tidal marsh habitat would not preclude use of the embayment by juvenile salmonids except during low tide periods.

6.7.3 Ecosystem Research Actions

Ecosystem research actions are measures proposed by the Corps to assist the efforts of the Corps, NMFS, FWS, and others in understanding the broader issues of the Lower Columbia River, estuary and river mouth. These research actions address indicators of the salmonid conceptual model, and are intended to provide useful information for the conservation and recovery of ESA-listed salmonids. The annual and cumulative results will be presented to the adaptive management team. NMFS strongly supports implementation of these ecosystem research activities.

Effects to ESA-listed salmonids are expected to occur from implementation of ecosystem research activities. Because any impact to ESA-listed salmonids from research activities is directed and intentional, instead of incidental to the purpose of the action, the future implementation of these research activities may require the issuance of research permits authorizing direct take of ESA-listed salmonids by NMFS under Section 4(d) or 10(a)(1)(A) of the ESA.

6.8 Summary of Effects of the Proposed Action on the Biological Requirements of Proposed and Listed Salmonids

NMFS' analysis in 6.2.1 of this Opinion indicated that direct effects to ESA-listed salmonids would be limited. NMFS concurs with the Corps' general assessment of potential Project indirect effects during the two-year construction period of navigation improvements. Based on the conceptual model, impacts to key physical processes have the potential for affecting habitat forming processes, i.e., the "building blocks"of salmonid habitat in the Lower Columbia River, estuary and river mouth. These key physical processes include suspended sediment, accretion/erosion, turbidity, salinity, bathymetry, and bedload. Impacts to these key physical processes will be of a limited nature during the Project construction period as discussed during the SEI panel process, and validated using the numerical modeling conducted by WES and OHSU/OGI. These results demonstrate that the indirect effects of the Project on ESA-listed salmonids in the short-term is limited.

Based on these limited, direct and indirect Project effects, NMFS believes population numbers of ESA-listed salmonids will not be appreciably reduced. NMFS also believes that the Project will not appreciably reduce, other than during short-duration and limited locations of salmonid avoidance of dredging and disposal operations, the distribution of ESA-listed salmonids. Of all ESA-listed salmonids, only Columbia River chum salmon spawning habitat occurs in the Project area. However, NMFS believes the direct and indirect effects of the Project will not appreciably reduce any of the ESA-listed salmonid ESUs' population numbers, distribution within each ESU, or reproductive success.

The 2001 BA characterized changes to key habitats and indicators over the life span of the Project as not being significant because they are within the natural variation of river conditions (e.g., changes to the ETM, accretion/erosion rates) or will not change river conditions at all (e.g., bedload changes, volume and rate of suspended sediment transport, water level changes to the estuary, structure, distribution, net productivity, and detritus production of marshes and swamps, the location of mobile macroinvertebrates, velocity changes in shallow water habitats and available refugia, salinity changes as they impact habitat types, bathymetry, and the impact on habitat opportunity as it relates to water depth in the estuary).

During the reinitiation of the consultation process, NMFS identified certain issues regarding potential long-term effects of the Project. Those issues centered on limited physical effects that may be caused by Project actions that are not detectable in the short term, but that may affect ESA-listed salmonid habitats over the life span of the Project. This could include ecosystem effects that are not identifiable based on the NMFS' review of best available science and our current understanding of the ecosystem. Topics of concern identified during this reinitiation include those related to the ETM, formation and preservation of tidal marsh and swamp habitats, habitat opportunity changes in isolated geographic areas, and elimination of connectivity between habitats relied on by juvenile salmonids.

The changes to physical processes resulting from the Project will likely result in limited incremental changes in the physical conditions in the Lower Columbia River, estuary and river mouth. Any changes in a static system should be predictable, using modeling and other tools. However, the ecosystem of the Lower Columbia River, estuary and river mouth is not a static system. Numerical modeling cannot account for this non-static state. As acknowledged in the 2001 BA, these changes will result in a new dynamic equilibrium in the Lower Columbia River ecosystem over the life span of the Project.

Notwithstanding the Corps' assessments, NMFS believes that the predicted changes to the physical system should not be extrapolated over the life span of the Project without additional monitoring and verification. In the example developed as part of the OHSU/OGI modeling for the reinitiation of consultation, the predicted changes to habitat opportunity in Cathlamet Bay for five one-week model simulations (Table 6-1 of the 2001 BA) are from model simulation runs over a short time duration. The 2001 BA draws on these model runs in reaching the conclusion that the proposed actions "will not have an impact on habitat opportunity as it relates to water depth." Based on the information provided in the 2001 BA, extrapolating these results over the life span of the Project, instead of limiting those results to the period modeled, does not fully acknowledge potential model limitations or long-term variability in the ecosystem.

A key conclusion from both the SEI panel process and BRT discussions was that even using the best available scientific data, there remains a degree of risk and uncertainty, albeit low, with our ability to link the limited physical changes in habitat elements predicted from the Project with long-term effects - either positive, negative or neutral - to ESA-listed salmonids or their habitats. Therefore, the BRT conducted a qualitative risk and uncertainly analysis (see Table 7-1 of the 2001 BA). That analysis documented the need for a precautionary approach to the protection of ecosystem elements (i.e., key indicators within each pathway of importance to salmonids). Therefore, the Corps proposes, and NMFS concurs, that a robust monitoring program and adaptive management process are appropriate to address the risk and uncertainties associated with key salmonid pathways and indicators identified in this Opinion.

7. CRITICAL HABITAT

As identified in Section 4.2 of this Opinion, Status of the Species and Critical Habitat, five critical habitat elements may be affected by this action: Riparian vegetation, water quality, substrate, food, and safe passage. These habitat elements were included in the development of the conceptual ecosystem model. Because of their incorporation into the conceptual model, and additional analysis under 6.2.1 of this Opinion, the potential effects to critical habitat have been fully addressed in the effects analysis of this Opinion. These habitat elements have also been accounted for in the proposed action as part of the monitoring program (see Chapter 7 of the 2001 BA).

As noted in the Corps' April 2002, 2001 BA amendment letter (Table 6-3), all of the new upland disposal sites are not considered to provide elements of critical habitat for ESA-listed salmonids. For the existing disposal sites identified in the amendment letter and analyzed in Section 6.2.1 of this Opinion, Direct Effects, the disposal operations at existing upland sites are likely to have limited, localized negative effects on the elements of designated critical habitats, with longer-term benefits.

Indirect effects to safe passage are analyzed in Sections 6.2.1 and 6.5 of this Opinion. Effects to riparian vegetation and substrate were addressed in the analysis of habitat forming processes, habitat complexity, connectivity, and conveyance, and refugia (see Section 6.2.2 of this Opinion). Effects to food (i.e., prey base of juvenile salmonids) were addressed in Sections 6.3 and 6.4 of this Opinion. Water quality effects were analyzed in the following portions of this Opinion: Suspended sediment (Section 6.2.2.1), turbidity (Section 6.2.2.3), water column habitat (Section 6.3.3), and contaminants (Section 6.4.2).

With the exception of the Cottonwood-Howard island translocation of Columbian white-tailed deer and Shillapoo Lake (no salmon access), the proposed ecosystem restoration features will have the potential to benefit designated critical habitat (see April 15, 2002, amendment letter [Table 6-3]). For the proposed wildlife mitigation features identified in Table 6-3 of the amendment letter, these sites are likely to have limited, localized negative effects on the elements of designated critical habitats during construction. Once constructed, these sites have the potential for long-term benefits to the elements of designated critical habitat.

NMFS has reviewed the direct and indirect effects of the proposed action on the physical and biological features that were the basis for designating critical habitat in the Lower Columbia River and estuary. NMFS does not believe, based on the analysis presented in chapters 6 and 7 of this Opinion, that the Project will appreciably diminish the value of critical habitat physical and biological features, including riparian vegetation, water quality, substrate, food, and safe passage.

8. CUMULATIVE EFFECTS

8.1 Introduction

Cumulative effects are defined in 50 CFR part 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." The action area of the proposed action under consideration encompasses the Lower Columbia River (from Bonneville Dam downstream to the upper end of the estuary at RM 40), estuary (RM 40 to RM 3), and river mouth (RM 3 to the deep water disposal site).

The Project area is currently a disturbed estuarine ecosystem altered by previous dredging to establish the navigation channel, disposal of dredged material, diking and filling, sewage and industrial discharges, water withdrawal, and flow regulation, to highlight a few of the anthropogenic activities that have occurred over the last 100 years. Future Federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities are being (or will be) reviewed through separate section 7 consultation processes and are not considered cumulative effects.

State, Tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water use patterns, including ownership and intensity, any of which could affect ESA-listed salmonids or their habitats. Even actions that are already authorized are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities and many private land holdings, make any analysis of cumulative effects difficult. This section identifies representative actions and ongoing state and Tribal fish and habitat restoration plans that, based on currently available information, are reasonably certain to occur. It also identifies, to the extent currently possible, existing goals, objectives, and proposed plans by state and Tribal governments. However, NMFS is unable to determine at this point in time whether such proposed plans will in fact result in specific actions which will subsequently lead to cumulative effects.

8.2 State Actions

Each state in the Columbia River basin administers the allocation of water resources within its borders. Water resource development has slowed in recent years. Most arable lands have already been developed, the increasingly diversified regional economy has decreased demand, and there are increased environmental protections. If, however, substantial new water developments occur, cumulative adverse effects to ESA-listed salmonids are likely. NMFS cooperates with the state water resource management agencies in assessing water resource needs in the Columbia River basin. Through restrictions in new water developments, vigorous water markets may develop to allow existing developed supplies to be applied to the highest and best use. Interested parties have applied substantial pressure, including ongoing litigation, on the state water resource management agencies to reduce or eliminate restrictions on water development. It is, therefore, impossible to predict the outcomes of these efforts with any reasonable certainty.

In the past, each Columbia River Basin state’s economy depended on natural resources, with intense resource extraction. Changes in the states’ economies have occurred in the last decade and are likely to continue, with less large-scale resource extraction, more targeted extraction, and significant growth in other economic sectors. Growth in new businesses, primarily in the technology sector, is creating urbanization pressures and increased demands for buildable land, electricity, water supplies, waste-disposal sites, and other infrastructure.

Economic diversification has contributed to population growth and movement in all four states, a trend likely to continue for the next few decades. Such population trends will result in greater overall and localized demands for electricity, water, and buildable land in and near the action area; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure. The impacts associated with these economic and population demands will probably affect habitat features such as water quality and quantity, which are important to the survival and recovery of the ESA-listed salmonids. The overall effect will be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address impacts to habitat features. Oregon also has a statewide, land-use planning program that sets goals for growth management and natural resource protection. Washington State enacted a Growth Management Act to help communities plan for growth and address the effects of growth on the natural environment. If the programs continue, they may help lessen the potential for the adverse effects discussed above.

In July 2000, the governors of Idaho, Montana, Oregon, and Washington released their "Recommendation for the Protection and Restoration of Fish in the Columbia River Basin," with the stated goal of "protection and restoration of salmonids and other aquatic species to sustainable and harvest able levels meeting the requirements of the Endangered Species Act, the Clean Water Act, the Northwest Power Act and tribal rights under treaties and executive orders while taking into account the need to preserve a sound economy in the Pacific Northwest." The recommendations include the following general actions related to the Lower Columbia River:

Habitat Reforms

- Designate priority watersheds for salmon and steelhead.
- Provide local watershed planning assistance and develop the priority plans by October 1, 2002, and for all Columbia River basin watersheds by 2005.
- Integrate Federal, state, and regional planning processes with the Northwest Power Planning Council's amended Fish and Wildlife Program.
- Cooperate with Federal, Tribal, and local governments to implement the National Estuary Program for the Lower Columbia River estuary, including creation of salmon sanctuaries.

Funding and Accountability

- Seek funding assistance for existing activities designed to improve ecosystem health and fish and wildlife health and protection.
- Work regionally to create a standardized and accessible information system to document regional recovery progress.

If these recommendations are implemented by the States individually and collectively, they should have beneficial effects on ESA-listed salmonids and their habitats.

8.2.1 Oregon

Most future actions by the state of Oregon are described in the Oregon Plan for Salmon and Watershed measures, which include the following programs designed to benefit salmon and watershed health in the Lower Columbia River:

- Oregon Department of Agriculture water quality management plans.
- Oregon Department of Environmental Quality development of Total Maximum Daily Loads (TMDLs) in targeted basins; implementation of water quality standards.
- Oregon Watershed Enhancement Board funding programs for watershed enhancement programs, and land and water acquisitions.
- Oregon Department of Fish and Wildlife (ODFW) and Oregon Water Resources Department (OWRD) programs to enhance flow restoration.
- OWRD programs to diminish over-appropriation of water sources.
- ODFW and Oregon Department of Transportation programs to improve fish passage; culvert improvements/replacements.
- Oregon Division of State Lands and Oregon Parks Department programs to improve habitat health on state-owned lands.
- State agencies funding local and private habitat initiatives; technical assistance for establishing riparian corridors; and TMDLs.

If the foregoing programs are implemented, they may improve habitat features considered important for ESA-listed salmonids. The Oregon Plan also identifies private and public cooperative programs for improving the environment for ESA-listed salmonids. The success and effects of such programs will depend on the continued interest and cooperation of the parties.

8.2.2 Washington

The state of Washington has various strategies and programs designed to improve the habitat of ESA-listed salmonids and assist in recovery planning. Washington's 1998 Salmon Recovery Planning Act provided the framework for developing watershed restoration projects and established a funding mechanism for local habitat restoration projects. It also created the Governor's Salmon Recovery Office to coordinate and assist in the development of salmon recovery plans. Washington's "Statewide Strategy to Recover Salmon," for example, is designed to improve watersheds.

The Watershed Planning Act, also passed in 1998, encourages voluntary planning by local governments, citizens, and Tribes for water supply and use, water quality, and habitat at the Water Resource Inventory Area or multi-Water Resource Inventory Area level. Grants are made available to conduct assessments of water resources and to develop goals and objectives for future water resources management. The Salmon Recovery Funding Act established a board to localize salmon funding. The board will deliver funds for salmon recovery projects and activities based on a science-driven, competitive process. These efforts, if developed into actual programs, should help improve habitat for ESA-listed salmonids.

Washington's Department of Fish and Wildlife and tribal comanagers have been implementing the Wild Stock Recovery Initiative since 1992. The comanagers are completing comprehensive species management plans that examine limiting factors and identify needed habitat activities. The plans also concentrate on actions in the harvest and hatchery areas, including comprehensive hatchery planning. The Department and some western Washington treaty Tribes have also adopted a wild salmonid policy to provide general policy guidance to managers on fish harvest, hatchery operations, and habitat protection and restoration measures to better protect wild salmon runs.

Washington State's Forest and Fish Plan were promulgated as administrative rules. The rules are designed to establish criteria for non-federal and private forest activities that will improve environmental conditions for ESA-listed salmonids. The Washington legislature may amend the Shoreline Management Act, giving options to local governments for complying with endangered species requirements in marine areas.

The state of Washington also established the Lower Columbia Fish Recovery Board to begin drafting recovery plans for the lower Columbia region. The future impacts of the board's efforts will depend on legislative and fiscal support. The Washington Department of Transportation is considering changing its construction and maintenance programs to diminish effects on stream areas and to improve fish passage. The program may qualify for a limit under NMFS' 4(d) rule to conserve ESA-listed salmonids.

Water quality improvements will be proposed through development of TMDLs. The state of Washington is under a court order to develop TMDL management plans on each of its 303(d) water-quality-listed streams. It has developed a schedule that is updated yearly; the schedule outlines the priority and timing of TMDL plan development.

Washington State closed the mainstem Columbia River to new water rights appropriations in 1995. All applications for new water withdrawals are being denied based on the need to address ESA issues. The state established and funds a program to lease or buy water rights for instream flow purposes. This program was started in 2000 and is in the preliminary stages of public information and identification of potential acquisitions. These water programs, if carried out over the long term, should improve water quantity and quality in the state.

As with Oregon's state initiatives, Washington's programs are likely to benefit ESA-listed salmonids if they are implemented and sustained.

8.3 Local Actions

Local governments will be faced with similar and more direct pressures from population growth and movement. There will be demands for development in rural areas, as well as increased demands for water, municipal infrastructure, and other resources. The reaction of local governments to growth and population pressure is difficult to assess without certainty in policy and funding. However, future development in Oregon will be governed for the foreseeable future by Oregon's statewide land use planning program, and Washington's will be governed by its Growth Management Act, both of which address issues of natural resource protections.

Increased industrialization associated with regional economic trends and growth patterns may also have the potential to result in additional dredging around dock facilities, alteration and loss of riparian areas, increased pollution, alteration and loss of shallow water habitat, and potential additional dredging for deeper access channels to enable ports to compete with other west coast port facilities. Because there is little consistency among local governments regarding current ways of dealing with land use and environmental issues, both positive and negative effects on ESA-listed salmonids and their habitats from other development caused by regional and national growth trends will probably be scattered throughout the action area.

In Oregon and Washington, most local governments are considering ordinances to address effects on aquatic and fish habitat from different land uses. The programs are part of state planning structures. Some local government programs, if submitted, may qualify for a limit under NMFS' 4(d) rule and/or a Section 10 HCP process which is designed to conserve ESA-listed salmonids. Local governments may also participate in regional watershed health programs, although political will and funding will determine participation and, therefore the effect of such actions on ESA-listed salmonids.

As identified in the FCRPS Hydropower biological opinion, the Lower Columbia River Estuary Partnership (LCREP) works with private environmental groups, Federal, state, and local governments on ecosystem protection of the Lower Columbia River. Through continued implementation of their Comprehensive Conservation and Management Plan (CCMP), LCREP encompasses a watershed wide perspective, cross cutting political boundaries to address land use, water quality, and species protection. LCREP coordinates and implements a program for conservation of the Lower Columbia River. LCREP is also actively working with NMFS on recovery planning for salmonids. Thus, there is potential for a comprehensive, cohesive, and sustained program for species recovery in the Lower Columbia River.

8.4 Tribal Actions

Tribal governments will participate in cooperative efforts involving watershed and basin planning designed to improve aquatic and fish habitat. The earlier discussion of the effects of economic diversification and growth applies also to Tribal government actions. Tribal governments have to apply and sustain comprehensive and beneficial natural resource programs such as the ones described below, to areas under their jurisdiction to have measurable positive effects on ESA-listed salmonids and their habitats.

One Tribal program illustrates future Tribal actions that should have such positive effects. The *Wy-Kan-Ush-Mi Wa-Kish-Wit*, or "Spirit of the Salmon" plan is a joint restoration plan for anadromous fish in the Columbia River basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. It provides a framework for restoring anadromous fish stocks, specifically salmon, Pacific lamprey (eels), and white sturgeon in upriver areas above Bonneville Dam. The plan's objectives related to the estuary are as follows:

- Protect the remaining wetlands and intertidal areas in the estuary upon which anadromous fish are particularly dependent.
- Undertake an immediate assessment of remaining and potential estuary habitat.
- Protect existing estuary habitat complexity.
- Evaluate and condition additional proposals for hydroelectric and water withdrawal developments, navigation projects, and shoreline developments on the basis of their impact on estuarine ecology.
- Identify and implement opportunities to reclaim former wetland areas by breaching existing dikes and levees.
- Reestablish sustained peaking flows that drive critical river and estuarine processes.

The plan emphasizes strategies and principles that rely on natural production and healthy river systems. The plan's technical recommendations cover hydroelectric operations on the mainstem Columbia and Snake rivers; habitat protection and rehabilitation in the basin above Bonneville Dam, in the Columbia estuary, and in the Pacific ocean; fish production and hatchery reforms; and in river and ocean harvests. Overall, future implementation of the Spirit of the Salmon plan should have positive cumulative effects on ESA-listed salmonids and their habitats.

The Nez Perce, Warm Spring, Umatilla, and Yakama Tribal governments are now seeking to implement this plan and salmon restoration in conjunction with the states, other Tribes, and the Federal government, as well as in cooperation with their neighbors throughout the basin's local watersheds and with other citizens of the Northwest.

8.5 Private Actions

The effects of private actions are the most uncertain. Private landowners may convert their lands from current uses, or they may intensify or diminish those uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or they may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects are even more so.

There are a number of private environmental groups working in the Lower Columbia River on conserving and restoring ecosystem functions that benefit salmonids. Those groups include the North American Joint Waterfowl Plan, Ducks Unlimited, Sea Resources, the Columbia Land Trust, and the Columbia River Estuary Study Task force. As independent organizations, each environmental group has its own charter and therefore function independently. However, these groups are coordinating their work through LCREP's science workgroup. Overall, their actions should have positive cumulative effects on ESA-listed salmonids and their habitats.

8.6 Cumulative Effects Summary

Non-federal actions are likely to continue to affect ESA-listed salmonids. The cumulative effects of non-federal actions in the action area that are reasonably certain to occur are difficult to analyze, considering the broad geographic landscape covered by this Opinion, the geographic and political variation in the action area, the uncertainties associated with state, Tribal, and local government and private actions, and ongoing changes to the region's economy. Many negative effects, such as impacts to fish habitat from continued urbanization, water extraction, and water quality alterations, are reasonably certain to occur. However, State, Tribal, and local governments have developed plans and initiatives to benefit ESA-listed salmonids. LCREP's CCMP is another important tool currently being used to coordinate organizations as they conduct habitat conservation, restoration, and recovery actions that benefit anadromous fish. Although State, Tribal and local governments have developed plans and initiatives to benefit listed salmon and steelhead, they must be applied and sustained in a comprehensive manner before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects. However, the data and information generated from the above identified ESA-listed salmonid plan actions can be incorporated into the Project's adaptive management process to help guide future management of the Project.

9. CONCLUSION

9.1 Introduction

The analysis in the proceeding sections of this biological opinion forms the basis for conclusions as to whether the proposed action, the Columbia River Federal Navigation Channel Improvements Project, satisfies the standards of section 7(a)(2) of the ESA. To do so, the Corps must ensure that their proposed action is not likely to jeopardize the continued existence of any listed species or destroy or adversely modify designated critical habitat. Section 3 of this Opinion describes the constituent components of the proposed action. Section 4 outlines the biological requirements and current status of the listed salmon and steelhead species considered in this Opinion. Section 5 evaluates the relevance of the Lower Columbia River and estuary environmental baseline to the listed species' current status. Section 6 details the likely effects of the proposed action, both on individuals of the listed species in the action area, as well as to the properly functioning condition of their habitat. Section 7 considers the cumulative effects of relevant non-federal actions reasonably certain to occur in the action area. On the basis of this information and analysis, NMFS draws its conclusions about the effects of the Project on the survival and recovery of the listed salmonid species.

In this concluding section, NMFS analyzes whether the proposed action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitats. Jeopardy is defined as an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species [50 CFR § 402.02]. Adverse modification or destruction of critical habitat is defined as an action's direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species [50 CFR § 402.02].

NMFS recognizes the importance of the Lower Columbia River and estuary to the survival and recovery of ESA-listed salmonids, in particular, ocean-type chinook and chum salmon. The FCRPS Hydropower biological opinion and the Northwest Fisheries Science Center draft report, Salmon at the River's End (Bottom et al., 2001), acknowledge that conservation and restoration of habitat in this portion of the Columbia River Basin is essential to the eventual recovery of ESA-listed salmonids.

9.2 Summary of Navigation Channel Improvement Effects

Based on the effects analyses in Section 6 of this Opinion, NMFS believes that the most predictable impacts from the proposed action to ESA-listed salmonids and their habitats in the Lower Columbia River, estuary and river mouth are short-term, physical changes during the construction and subsequent maintenance periods of the Project. Impacts to key physical processes have the potential to affect habitat forming processes. However, expected impacts to these key physical processes will be limited and short-term in nature during the Project construction and maintenance periods. This conclusion was verified during the SEI panel process, as well as during BRT discussions of the numerical modeling conducted by WES and OHSU/OGI. Therefore, Project construction and maintenance impacts to key habitat types (i.e., tidal marsh and swamp, shallow water and flats, and water column) should be limited as well.

Section 6.2.1 (Direct Effects) indicated Project construction and maintenance would have limited potential to result in the incidental take of ESA-listed salmonids via dredging entrainment and blasting activities. Additionally, Section 6.2.1 found that the Project's effects would not diminish the value of the physical or biological features of critical habitat.

Our indirect effects analysis also determined that short-term, physical changes to any of the habitat-forming process indicators (Section 6.2) during Project construction and maintenance periods are unlikely to have more than a limited adverse effect on any of the habitat indicators identified in Section 6.3 of this Opinion. Section 6.4 of this Opinion analyzes indicators that occur in more than one key habitat. Based on minor predicted changes to key physical habitat-forming processes discussed above, short-term Project effects to habitat complexity, connectivity, and conveyance, feeding habitat opportunity, refugia, and habitat-specific food availability are expected to be limited.

Contaminants (Section 6.4.2 of this Opinion) are another indicator that can affect more than one habitat type. NMFS' concerns over resuspension of contaminants by the Project were raised in our August 25, 2000, withdrawal letter. The environmental baseline clearly indicates that juvenile salmonids are being exposed to toxicants in their food supply (see Section 5 of this Opinion) in the estuary. However, while the source of those toxicants is not clear, the potential of the Project to exacerbate this situation is unlikely given the characteristics of the material being dredged and disposed of during the construction period. To be as protective as possible, Monitoring Action 5, identified in Table 7-3 of the 2001 BA (page 7-9), addresses the potential for release of contaminants during the construction process and will help identify and minimize the potential to resuspend contaminants during Project construction and maintenance activities.

Based on the limited direct and indirect Project effects on the key indicators of the estuarine habitat Conceptual Model, NMFS concludes that the proposed action would not prevent or delay the achievement of properly functioning habitat conditions for listed species within the action area. In addition, population numbers of ESA-listed salmonids will not be appreciably reduced. NMFS also believes that the Project, other than during short-duration and limited locations of salmonid avoidance of dredging and disposal operations, will not appreciably reduce the distribution of ESA-listed salmonids. Of all ESA-listed salmonids, only Columbia River chum salmon spawning habitat occurs in the Project area. However, NMFS believes the direct and indirect effects of the Project will not appreciably reduce any of the ESA-listed salmonid ESUs' population numbers, distribution within each ESU, or reproductive success. NMFS also believes that the physical and biological features (riparian vegetation, water quality, substrate, food, and safe passage) of Lower Columbia River and estuary critical habitat will not be appreciably diminished in value over the long-term. Therefore, NMFS believes that the Project will not appreciably reduce the likelihood of survival and recovery of ESA-listed salmonids.

9.3 Monitoring and Adaptive Management

Because of the low levels of risk and uncertainty surrounding the long-term biological response of ESA-listed salmonids to predicted physical changes, the best available scientific information does not allow NMFS to predict with certainty how the limited physical changes would affect ESA-listed salmonids and their habitats over the life span of the Project. Section 6.8 of this Opinion discusses long-term uncertainty and risk, and reviews the need for reducing long-term uncertainty and risk via a precautionary approach to the protection of ecosystem elements (i.e., key indicators within each pathway of importance to salmonids). Therefore, the Corps proposes, and NMFS concurs, that a robust monitoring program and adaptive management process will address the risk and uncertainties associated with key salmonid pathways and indicators identified in this Opinion. Implementation of the monitoring and adaptive management programs will ensure that long-term Project effects are addressed, and that these long-term effects will not appreciably reduce the likelihood of ESA-listed salmonid survival and recovery through the diminishment of properly functioning habitat conditions.

Monitoring and adaptive management will allow NMFS to verify our conclusion that the Project's long-term adverse effects to ESA-listed salmonids and their habitats are likely to be limited. Based on the results of the monitoring plan and adaptive management process, adjustments may be made to the construction and maintenance activities of the Project. As an additional result of annual monitoring program review, the adaptive management team may decide that mitigation or restoration actions will be necessary to address adverse impacts.

The monitoring program elements and the framework for the adaptive management process, as currently proposed in the 2001 BA, address the main concerns identified in Section 6 (Effects of the Proposed Action), and will ensure that Project-related environmental impacts to the Lower Columbia River, estuary and river mouth are minimized. NMFS also believes that the monitoring program and the adaptive management process provide the Corps with the opportunity to integrate elements of the Project into a broader set of research objectives and restoration activities in the Columbia River Basin (i.e., estuary action items in the All-H paper and the FCRPS Hydropower biological opinion).

NMFS and FWS have jointly published a policy statement on adaptive management in the context of and for its habitat conservation plan and safe harbor strategies. While the HCP context may vary in some respects from the implementation of the proposed action, the policy statement provides instructive guidance on the key elements of a scientifically credible adaptive management strategy. As NMFS, FWS and the Corps work to refine the adaptive management process governing the implementation of this proposed action, NMFS and FWS will look to the fundamental elements of its guidance for adaptive management, which may be found in 65 FR 106 at 35242, 35252 (July 1, 2000).

9.4 Ecosystem Research Actions

The Corps has proposed a series of ecosystem research actions (Table 8-1 of the 2001 BA) under section 7(a)(1) of the ESA. The proposed ecosystem research actions support currently on-going research actions in the Lower Columbia River. They also begin to address longer-term environmental issues of the river's ecosystem, such as contaminants, and will provide a venue via the proposed workshop to better understand and propose meaningful management actions to conserve the ETM. The data and information resulting from the ecosystem research actions can also be brought forward into the adaptive management process to inform and guide future management decisions associated with the Project.

9.5 Ecosystem Restoration Features

The Corps has proposed multiple ecosystem restoration features (see Table 8-2 of the 2001 BA) in furtherance of section 7(a)(1) of the ESA. During BRT discussions, and discussions among the Corps, the Ports, FWS, and NMFS management, participants identified the need to address any proposed restoration features in the context of habitat type, function, and value, and to link those values to ESA-listed salmonids, particularly juvenile salmonids. The ecosystem restoration features also respond to the indications in Sherwood et al. (1990) and Bottom et al. (2001) regarding estuarine habitat losses and habitats important for restoring the estuary to properly functioning conditions.

An important distinction between the 1999 biological opinion and this Opinion is that the Project now includes these restoration features as part of the proposed action. By including the restoration features as part of the Project, the Corps has significantly increased the certainty that these activities will occur and has provided NMFS with the opportunity to evaluate their potential effects on ESA-listed salmonids and designated critical habitat for those species.

The ecosystem restoration features will provide benefits to the habitat types identified in the Conceptual Model (see Chapter 5 of the 2001 BA). When implemented in coordination with NMFS and other entities conducting habitat conservation/restoration activities, these features should complement those activities currently occurring in the Lower Columbia River and estuary. For these reasons, NMFS believes that the proposed ecosystem restoration features will benefit ESA-listed salmonids and their habitats. As with the monitoring plan, the adaptive management process, and the ecosystem research actions, the ecosystem restoration features also provide the Corps the opportunity to integrate elements of the Project into a broader suite of research objectives and restoration activities in the Columbia River Basin (i.e., estuary action items in the Basinwide Salmon Recovery Strategy or "All-H" paper and the FCRPS Hydropower biological opinion).

9.6 Conclusion

After reviewing the current status and factors for decline of of ESA-listed salmonids included in this consultation, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Snake River sockeye salmon, Snake River fall chinook salmon, Snake River spring/summer chinook salmon, Snake River Basin steelhead, Upper Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Columbia River chum salmon, Lower Columbia River chinook salmon, Upper Willamette River chinook salmon, and Upper Columbia River spring run chinook salmon, or result in the destruction or adverse modification of their designated critical habitat. In reaching this conclusion, NMFS relied on the best available scientific and commercial data.

10. CONSERVATION RECOMMENDATIONS

10.1 Introduction

Section 7 (a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on ESA-listed salmonids, to minimize or avoid adverse modification of designated critical habitat, to help implement recovery plans, or to develop additional information.

10.2 Conservation Recommendations

NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by the Corps:

10.2.1 Pile Dike Study

Coordinate with NMFS, FWS, and OSHU/OAI to develop and implement a study that addresses the functioning of and continued need for pile dike fields in the Lower Columbia River, estuary and river mouth in relationship to on-going and future habitat conservation/restoration activities. The study results should be used to assess how pile dike fields might be modified and/or removed from the Lower Columbia River, estuary and river mouth to enhance habitat conservation/restoration activities in a manner that does not compromise the integrity of the navigation channel. The results of this study should be incorporated into future consultations for maintenance of the navigation channel and any future reinitiation of consultation activities stemming from the September 15, 1995, ESA section 7 consultation on operation and maintenance dredging from John Day Dam to the Mouth of the Columbia.

10.2.2 Ecosystem Conservation/Restoration

There are a number of on-going habitat conservation/restoration activities in the Lower Columbia River and estuary that are being conducted by the LCREP, the Salmon Recovery Funding Board, the Lower Columbia Fish Recovery Board, Oregon Watershed Enhancement Board, and a number of non-profit organizations. Based on the need to support this continuing work and NMFS and FWS future fish and wildlife recovery efforts, the Corps should continue to implement habitat conservation/restoration activities, as identified through this consultation and other appropriate Corps authorities, including the All-H document, FCRPS Hydropower biological opinion (RPA Action items 158 - 163; 194 - 197), Sections 1135, 206, and 536 of the Water Resources Development Act (WRDA), and the Corps General Investigation Report - Section 905(b)(WRDA 86) Analysis, Lower Columbia River Ecosystem Restoration, Oregon and Washington, (May, 2001).

The Corps should explore how to employ regulatory flexibility as they implement their authorities when working with potential partners on conservation/restoration activities.

The Corps should continue to work on the implementation of LCREP's CCMP via providing policy and technical assistance. The Corps should also work with the LCREP partners to use their annual planning and Congressional appropriation process to establish and provide the appropriate level of funding to implement the CCMP (in particular, Actions 1 - 12, and 28).

10.2.3 Sediment Budget for the Lower Columbia River and Estuary

The Corps should conduct a sediment budget study that includes an analysis of historic sediment volumes in the Lower Columbia River, how sediment volumes have changed with development of the FCRPS, and how the deepening of the channel from 0-43 feet further modified sediment inputs into the system. The Corps should ensure that development and implementation of this study is consistent with Action Items 158, of the FCRPS Hydropower biological opinion (December, 2000).

10.2.4 Near-shore and Plume Study

The Corps should develop and implement a study(ies) examining the potential for impact to near-shore and plume environments produced by ocean disposal of sediments produced by the Project. The areas included in this study(ies) should include all existing and proposed disposal sites at the Mouth of the Columbia River. The study should examine salmonid use of in these areas, (abundance, distribution, food resources, habitat). This study should build upon the current research being conducted by NMFS' Northwest Fisheries Science Center.

a. The study design and plan for ocean disposal of sediments should be submitted to NMFS and the FWS for final approval.

b. The results of the study and the plan for ocean disposal of sediments should be presented to the adaptive management team for consideration during the adaptive management process. The results of this study should be incorporated into future consultations for the navigation channel and the any future reinitiation of consultation activities stemming from the Mouth of the Columbia River maintenance project.

10.2.5 Public Involvement in the Adaptive Management Process

For the adaptive management process to be successful, the process should be a transparent one. The annual adaptive management meetings should be open to the public. During each meeting, there should be an opportunity for questions, comments, and technical input from the public, with response from the adaptive management team. Copies of public comments, data, and information discussed during the meetings should be placed on the Corp's website.

10.2.6 OHSU/OGI ELCIRC Modeling

The OHSU/OGI ELCIRC model analyzed Columbia River estuary habitat opportunity changes between current and future Project conditions. It would be very useful to extend this analysis to riverine portions of the Project area. The Corps should fund the expansion of the ELCIRC model to incorporate the riverine portions of the Project area, and provide those modeling outputs to the adaptive management team for review and consideration.

10.2.7 Pipeline Dredge Disposal

While ESA-listed salmonids mainly use the upper 20 feet of the Columbia River and estuary's water column, these fish may also use deeper portions of the water column for movement and migration. Pipeline dredges, when disposing of materials in or adjacent to the navigation channel, release dredged materials below 20 feet in depth. Fish using water deeper than 20 feet may temporarily encounter a turbidity plume associated with these disposal activities. Where feasible and safe, NMFS recommends that the Corps release pipeline-dredged materials into as deep a depth as possible.

10.2.8 Control of Non-Indigenous Species

NMFS recommends that the Corps continue its efforts to minimize and/or avoid future, non-indigenous species introductions from deep draft vessel traffic associated with the deepened navigation channel by assisting the Coast Guard, and States of Oregon and Washington, in implementing rules to minimize ballast discharge and associated invasive species introductions.

10.2.9 Involvement of the Columbia River Tribes in Project Implementation

The Columbia River Tribes, represented by the Columbia River Intertribal Fish Commission (CRITFC), have specific technical expertise that should be included into the Project implementation. The Corps should encourage CRITFC participation in the following Project activities: Adaptive management process, monitoring program, ecosystem research program, and the annual contaminants review team activities (see table 3.5). The Corps should also encourage CRITFC participation with the Regional Sediment Evaluation Team that is updating the DMEF manual. The Corps should provide funding for CRITFC involvement in these Project and Project-related activities.

11. REINITIATION OF CONSULTATION

Consultation must be reinitiated as follows:

This concludes formal consultation on these actions in accordance with 50 CFR 402.14(b)(1). Reinitiation of consultation is required: (1) If the amount or extent of incidental take is exceeded; (2) if the action is modified in a way that causes an effect on ESA-listed salmonids that was not previously considered in the biological assessment and this Opinion; (3) if through the monitoring and adaptive management process, or by any other means, new information or project monitoring reveals effects on the action that may affect the ESA-listed salmonids in a way not previously considered or in a way not predicted by the 2001 BA or this Opinion; or (4) a new species is listed or critical habitat is redesignated that may be affected by the action (50 CFR 402.16)

12. INCIDENTAL TAKE STATEMENT

12.1 Introduction

Sections 4(d) and 9 of the ESA prohibit any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of listed species without a specific permit or exemption. Harm in the definition of "take" in the ESA means an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR 222.102, 2001). Harass is defined as actions that create the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is take of listed animal species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary. They must be implemented by the action agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement. If the Corps (1) fails to adhere to the terms and conditions of the incidental take statement, and/or (2) fails to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. The Corps will report to NMFS on annual progress toward implementing these reasonable and prudent measures.

An Incidental Take Statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

This Incidental Take Statement becomes effective at the point of signature of this Opinion, and continues to apply through construction and into the maintenance period of the Project. This Incidental Take Statement will be reviewed every year during the annual meeting of the adaptive management team. As appropriate, NMFS will determine whether reinitiation of consultation is indicated based on new information resulting from the adaptive management process.

12.2 Amount or Extent of the Take

The NMFS anticipates that the proposed action covered by this Opinion will result in short-term and long-term incidental take of ESA-listed salmonids. These types and amount of take are described below.

Based on BRT discussions of the conceptual model, other BRT deliberations including the SEI workshops, and use of the conceptual ecosystem model and numerical models in the effects analysis (see Section 6. of this Opinion), short-term incidental take of ESA-listed salmonids is likely to occur. Short-term incidental take, in the form of killing and injury from blasting and entrainment, is likely to occur during channel construction and maintenance actions. Short-term take, in the form of harm, is likely to occur from loss of salmonid prey items from entrainment and burial during disposal, and loss of limited amounts of low quality shallow water and shoreline salmonid habitat from side-slope adjustment and erosion. Additional short-term take is likely to occur from dredge and disposal-induced turbidity, which will harass ESA-listed salmonids by temporarily modifying their behavior.

Based on the effects analysis in Chapter 6.0 of the 2001 BA, the Corps concludes that few, if any, ESA-listed salmonids are likely to be directly taken as a result of blasting actions. Therefore, NMFS limits the amount of allowable incidental take from the single blasting event to no more than ten adult ESA-listed salmonids and 50 juvenile ESA-listed salmonids. Incidental take occurring beyond these limits is not authorized by this consultation.

Based on the effects analysis in Chapter 6.0 of the 2001 BA, the Corps concludes that few, if any, ESA-listed salmonids are likely to be directly taken as a result of entrainment during dredging. However, due to the Corps' inability to monitor entrainment events during all dredging activities, it is difficult for NMFS to quantify an estimate of entrainment-induced incidental take. However, the 2001 BA indicates, based on sampling of hopper dredge entrainment events, no ESA-listed salmonids were entrained using hopper dredging methodologies proposed in the 2001 BA. The Corps has indicated that pipeline dredge entrainment is impossible to evaluate. Based on existing entrainment information, and the requirement that the dredge's draghead and/or cutterhead, to the extent possible, remains below the sediment surface during suction, NMFS believes an unquantifiable, but low amount of incidental take is likely to occur as a result of the proposed action covered by this Opinion.

For the long term, Project-related habitat modifications to the Lower Columbia River, estuary and river mouth may alter important ESA-listed salmonid habitats, and therefore cause harm to ESA-listed salmonids. Upland dredged material disposal sites proposed by the Corps have been sited by the Corps on existing disposal sites of low habitat value or else occur behind main flood control levees where ESA-listed salmonids are virtually excluded from access and export of detritus, terrestrial insects, and large woody debris is limited. An unquantifiable, but low amount of incidental take is likely to occur from use of these upland disposal sites. Implementation of certain ecosystem restoration features may result in a low level of unquantifiable take as a result of inwater fill or other construction related activities that temporarily disrupt production of benthic prey items, increases turbidity, and precludes use of the locations.

These habitat modifications may occur throughout the Project area. The indicators analyzed in Section 6.2.2 of this Opinion, Indirect Effects, could potentially be affected in the long term by the proposed action. Based on the risk and uncertainty analysis conducted by the BRT (see Table 7-1 of the 2001 BA), how these impacts would affect ESA-listed salmonids and their habitats is uncertain over the life span of the Project. However, the potential long-term effects to ecosystem indicators are not of high risk to ESA-listed salmonids (see Table 7-1 of the 2001 BA). Therefore, NMFS believes that long-term impacts will be adequately addressed through the proposed compliance measures, monitoring program, and adaptive management program.

Even though NMFS expects some low level of long-term incidental take to occur as a result of the proposed action covered by this Opinion, the best scientific and commercial data available are not sufficient to enable NMFS to estimate a specific amount of long-term incidental take over the life of the Project. Therefore, based on the information in the 2001 BA and the Opinion's effects analysis, NMFS anticipates that an unquantifiable, but low amount of incidental take over the life span of the Project is likely to occur as a result of the proposed action covered by this Opinion.

12.3 Effect of the Take

In the accompanying Opinion, NMFS determined that the level of anticipated and unquantifiable take is not likely to result in jeopardy to the species.

12.4 Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of ESA-listed salmonids from activities associated with navigation channel improvements:

1. Minimize incidental take associated with the interaction of channel improvements with BPA's ability to evaluate flow regimes.

2. Minimize the likelihood of incidental take associated with short-term (direct and indirect) impacts to listed salmonids during Project construction and maintenance activities.

3. Minimize the likelihood of incidental take associated with long-term uncertainty and associated risk regarding Project effects by implementing a monitoring program.

4. Minimize the likelihood of incidental take associated with project impacts by implementing an adaptive management process to review results of monitoring program and other applicable new information, and determine actions necessary to minimize any adverse effects.
5. Minimize the likelihood of incidental take during implementation of ecosystem restoration features that aid in the recovery of ESA-listed species in the Lower Columbia River, estuary and river mouth.

6. Provide NMFS with annual reports from Project compliance, monitoring, restoration, and research activities to ensure adequate organization, coordination, and reporting of all information resulting from the Project and this Opinion.

12.5 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. In order to minimize the likelihood of incidental take associated with the interaction of channel deepening with BPA's ability to evaluate flow regimes, the Corps shall coordinate with BPA to provide information necessary for them to carry out Action Item 162 of the FCRPS Hydropower biological opinion (December, 2000).

2. In order to minimize the likelihood of incidental take associated with short-term (direct and indirect) impacts to listed salmonids during Project construction and maintenance activities, the Corps shall do the following:

   a. Minimize effects from entrainment through the following actions:

i. Implement the dredging Impact Minimization Measures and Best Management Practices as identified in Chapter 3 of the 2001 BA.

ii. Monitor operation of the dredge draghead and/or cutterhead to minimize the time they are removed from the substrate.

b. Minimize effects from blasting through the following actions:

i. The blasting plan, outlined on page 6-20 of the FEIS for the Project, will be developed in conjunction with Federal and State agencies and submitted to NMFS for approval 30 days prior to blasting. The blasting plan will include specific monitoring actions to determine if any listed fish are killed or injured, and include a clause that, if the blasting results in a take of listed salmonids, the Corps will discontinue blasting until such time as that take can be assessed and measures enacted to minimize impacts.

ii. The results of the blasting plan monitoring shall be presented at the adaptive management team meeting during the year in which the blasting occurs.

c. Prior to navigation channel construction and maintenance implementation, the Corps shall provide a "contractor compliance plan" to NMFS for review and approval. The plan must describe specific compliance monitoring actions, designed to minimize impacts to ESA-listed salmonids, that will occur during dredging and disposal actions, as described in 2001 BA table 7-4, 7-5, and 7-6. In addition, the contractor shall be required to report to the Corps any unanticipated or unusual events or visual observations (e.g., water surface oil slicks, injured/dead fish, and/or unusual colored or smelling sediments) that are not required in the contractor compliance plan. If take of ESA-listed species is observed during compliance monitoring, the NMFS shall be contacted immediately to determine the need for Project modification, mitigation, or cessation.

3. In order to minimize the likelihood of incidental take associated with uncertainty and risk regarding long-term Project effects, the Corps shall implement a monitoring program with the following elements:

a. The Corps shall finalize and implement the monitoring program (Table 7-3 of the 2001 BA). All activities related to scope identification, i.e., goals, milestones for completion, and check-in points, triggers for management change (management decision points that include specific metrics), and sampling/testing protocols to be developed, will be coordinated with NMFS. The final monitoring program shall also ensure that adequate pre-, during, and post- construction monitoring actions occur to allow for comparable pre- and post-Project data analysis.

b. Two proposed monitoring actions, MA-1 and MA-3, shall be implemented over a longer time-scale (Term and Condition 5.a.1 of this Incidental Take Statement discusses Adaptive Management timeframes that link to long-term monitoring actions) than proposed in the 2001

BA. These monitoring activities are vital to understanding long-term Project-related changes to the Lower Columbia River, estuary and river mouth, and to allow for future adaptive management team decisions. Therefore, the Corps will continue, for the entire duration that the adaptive management program is operating, to collect and analyze data associated with MA-1 and MA-3 activities.

c. Through monitoring measure MA-4, the Corps shall ascertain Project related changes in habitat. Additionally, the Corps shall compare results of this monitoring action to any similar research efforts by the Northwest Fisheries Science Center's (i.e., their Columbia River estuary study) or other organizations in the estuary for a more complete assessment of habitat changes. At the end of the proposed monitoring period, monitoring results from MA-4 and associated research/monitoring shall be reviewed by the adaptive management team. The adaptive management team will determine whether additional MA-4 actions or a sub-component of MA-4 will go forward into the future.

d. In developing the above monitoring program information, the Corps will use the scope and sampling/testing protocols being implemented by the Northwest Fisheries Science Center in their on-going research activities in the Lower Columbia River and estuary as the basis for design. The final program will also describe how the various actions integrate together to form an ecosystem approach to evaluating ecosystem changes overtime.

    i. Submit the final monitoring program design to NMFS by December 15, 2002, for approval.
    ii. Implement the final monitoring program, as per the implementation dates.
    iii. Ensure that development and implementation of the monitoring program is consistent with Action Items 158, 159, 161, and 163 of the FCRPS Hydropower biological opinion (December, 2000).

e. The Corps shall continue to work with NMFS and FWS on the revision of the DMEF manual to develop a set of contaminant testing protocols appropriate for marine and fresh water environments. Upon final completion of the revised DMEF manual, the monitoring program will be updated based on the new manual based on the contaminants portion of the monitoring program (see Table 7-3 of the 2001 BA, item MA-5). These changes may require additional changes to the monitoring program. Any changes are deemed necessary, will be submitted to NMFS for review and approval prior to their implementation. The Corps shall continue to support the work of the Regional Sediment Evaluation Team that is updating the DMEF manual.

f. The best available information indicates that the Columbia River navigation channel sediments do not exceed current DMEF or NMFS contaminants thresholds. The interagency contaminants review team, identified in MA-5, shall ensure that the Project continues to proceed with the best available sediment and contaminant information. The interagency contaminants review team shall meet annually to review sampling distribution and frequency, sediment quality, and contaminants concerns of all Lower Columbia River, estuary and river mouth sediment sample locations. The interagency contaminants review team shall provide the adaptive management team with annual, or more regular, updates on current sediment and contaminants information in the Project area. Additionally, the interagency contaminants review team shall recommend to the adaptive management team, beginning at the first adaptive management team meeting in January, 2003, any additional sampling or contaminants testing necessary for purposes of minimizing contaminants resuspension from Project dredging and/or disposal activities. The Corps shall complete additional sediment and contaminant samples determined necessary by the adaptive management team. Any samples that the adaptive management team determines are necessary as a result of the January, 2003, meeting shall be completed prior to Project construction.

g. The Corps shall host an ETM workshop to better understand and propose meaningful management actions to conserve the ETM. The ETM workshop will be conducted by December 15, 2005. The Corps will coordinate the following actions with NMFS in the development of this workshop, including:

    i. Develop the scope of the meeting, agenda, and list of meeting attendees.
    ii. Make information obtained through monitoring and research available for the workshop.
    iii. Prepare a final report of the ETM workshop to be submitted to NMFS one month after completion of the workshop.
    iv. Present the results of the ETM workshop (final report) to the adaptive management team.
    v. Present management actions from the final ETM report to the adaptive management team for consideration in the adaptive management process.

h. The Corps shall minimize effects from stranding through the following actions:

    i. Develop and implement a stranding study to be developed in conjunction with NMFS, FWS, the Ports, and appropriate State agencies. The stranding study will evaluate parameters that influence stranding. Potential factors include: Cross-sectional area, velocity, water level, bank configuration, location along river, slope of bank, ship traffic past site, and type, size, draft, and speed of vessel. To the extent appropriate, the Corps will integrate this study with efforts related to implementation of the September 15, 1999, biological opinion on the operation and maintenance dredging from John Day Dam to the Mouth of the Columbia.
    ii. The scope of the stranding plan shall include an identified scope including goals, milestones for completion, check-in points, triggers for management change (i.e,

management decision points that include specific metrics), and sampling/testing protocols to be developed in coordination with NMFS.

iii. The results of the standing plan shall be used to develop a plan to minimize and/or eliminate fish stranding. The stranding minimization plan, as it applies to ship traffic will be provided to the U.S. Coast Guard, for use in their regulation of river traffic, and to the adaptive management team for consideration during the adaptive management process.

iv. The stranding study design shall be submitted to NMFS by December 15, 2002, for approval.

v. The standing study shall be implemented by April 2003.

vi. The results of the stranding study, including management recommendations to minimize stranding, shall be presented at the adaptive management team meeting (January, 2004). Management recommendations shall be reviewed by the adaptive management team and implemented where feasible.

vii. The stranding study will be repeated two years following construction of the deeper channel.

viii. Post construction stranding studies will be evaluated by the adaptive management team.

i. In the event the Project will use ocean disposal at the Deep Water Site (see Section 3.2.8 of the 2001 BA), the management plan for this disposal site will be coordinated with NMFS.

i. NMFS will be notified of and invited to all Ocean Dredged Material Disposal Site Taskforce meetings.

4. The Corps shall implement an adaptive management process to review results of the monitoring program and other applicable new information and determine actions necessary to minimize any adverse Project effect:

a. Establish the adaptive management team that implements the adaptive management process. The adaptive management team will meet annually (or more frequently if new circumstances arise) to review scientific information collected through monitoring, research, or best management practices while implementing this action.

b. The adaptive management team shall assess Project effects, and evaluate the effectiveness of the compliance measures, the monitoring program, research, and ecosystem restoration features. In doing so, the adaptive management team will ensure that Project construction, operation and maintenance, and ecosystem restoration activities have no greater impacts than predicted in the 2001 BA or in this Opinion and Incidental Take Statement.

c. If an adverse effect is determined by the adaptive management team, the Corps shall, within 30 days, submit an impact minimization plan to NMFS for approval. The Corps plan could range from proposing mitigation actions, to modifying or stopping the Project if warranted.

d. The Corps will work cooperatively with NMFS and FWS to develop goals, stated purposes, operating principles, and composition of the adaptive management team. The Corps should review 65 FR 35242 for a Service overview of using adaptive management for certain listed species decision-making and permitting activities. Portions of this Service policy document may be pertinent to the Corps' final design of the adaptive management process for this Project. The framework for actions taken by the adaptive management team shall be based on the following:

    i. Short-term (Years 0-5: Pre-construction, construction, and post-construction) - Focus shall be on potential short-term project impacts and modifications to minimize impacts. The effectiveness of the compliance measures, the monitoring program, research, and ecosystem restoration features will be evaluated. Additional mitigation features may be recommended for implementation and/or modifying or stopping the project if warranted.
    ii. Mid-term (Years 5-10) - Conduct trend analyses with monitoring data and research actions to detect ecosystem changes over the longer term and apply to actions identified above; and
    iii. Long-term (Years 10 and beyond) - Translate trend analysis information into long-term trends in ecosystem impacts and restoration of the ecosystem.

e. Information gathered through monitoring and research actions will be used to annually assess Project effects to the following indicators[6]:

    i. Shift in the location of the ETM,
    ii. ETM functions,
    iii. Accretion/erosion rates,
    iv. Habitat types,
    v. Food resources for salmonids,
    vi. Changes to sideslope adjustments adjacent to the entire navigation channel and associated loss of shallow water/flats or tidal marsh and swamp habitats in riverine and estuarine areas.
    vii. Physical features of habitat types, habitat opportunity, bathymetry, bedload changes, rate of suspended sediment transport, and water level changes to the estuary.

[6]These are minimum effects to be examined based on the state of knowledge at the time this Opinion was issued. As additional effects are identified, or the existing list of effects is modified, this list will be changed to fit the contemporary needs to the monitoring program and adaptive management process.

viii. Structure, distribution, net productivity, and detritus production of marshes and swamps,
ix. Velocity changes in shallow water habitats and available refugia, and
x. Salinity changes as they impact habitat types

f. The Corps shall submit the final design of the adaptive management process to NMFS by December 15, 2002 for approval.

g. The Corps shall conduct the first adaptive management team meeting in January, 2003. The adaptive management team will function for the duration of the monitoring program and prescribed ecosystem research actions. The Corps will provide facilitation support at all meetings of the adaptive management team.

h. The Corps shall ensure that development and implementation of the adaptive management process is consistent with Action Items 158, 159, 161, and 163 of the FCRPS Hydropower biological opinion (December, 2000).

5. In order to minimize the likelihood of incidental take through implementation of ecosystem restoration features (see Table 8-2 of the 2001 BA), the Corps shall:

a. Conduct all shallow water ecosystem restoration in-water construction activities, including excavation and dredge material placement, during approved in-water construction windows. The pipeline dredge in-water construction window for ecosystem restoration projects in the Lower Columbia River and estuary is November 1 to February 28. Hopper dredge disposal in deep water temporary storage sump locations, does not have an in-water construction window. The in-water construction window for Columbia River tidegate retrofit projects is July 1 to September 15.

b. To the extent practicable, maintain dredge draghead and/or cutterhead at or below the substrate surface during ecosystem restoration construction activities that require dredging activities.

c. To minimize the effects to ESA-listed salmonids and prey items during the Lois Island restoration activity, the Corps will submit a plan to outline how dredge material will be staged to constuct this feature, including measures to minimize resuspension of contaminants from the temporary storage sump.

d. Tide gate retrofits:

i. The Corps shall enter into an agreement with the Project sponsors that will require the sponsors to ensure future maintenance of retrofitted tidegates. In addition, the Corps will require guarantees from the Project sponsors that volitional fish passage, via timely operation of the tidegate passage features, will occur during key salmonid migration periods. The Corps will coordinate fish design for tidegate retrofits with Service fish passage engineers.

ii. The Corps shall coordinate fish passage designs for tidegate retrofits with NMFS fish passage engineers.

e. The Corps shall coordinate with NMFS on the development and implementation of the Purple Loosestrife Integrated Pest Management Plan, including prior NMFS review and approval for all over-water use of Rodeo®.

f. The Corps shall coordinate with NMFS on the development and implementation of pre- and post- monitoring protocols for the ecosystem restoration features to gauge their effectiveness in restoring the type, function, and value habitats identified in the 2001 BA. The Corps' restoration features monitoring plans shall be submitted to NMFS for review and approval by December 15, 2002.

6. The Corps shall provide NMFS with annual reports starting one year after the date of this Opinion regarding Project compliance, monitoring, restoration, and research activities. The report shall also summarize annual implementation of reasonable and prudent measures and their implementing terms and conditions:

a. Compliance:

i. The Corps will submit a series of reports based on the dredging Impact Minimization Measures and Best Management Practices for compliance (i.e., construction and maintenance) actions to NMFS in six month intervals during the construction process. These reports shall include the following minimum elements: a description of how the Corps implemented and responded to the impact minimization measures and BMPs, how much material was dredged and disposed of, how many fish were taken due to blasting, were any unusual sediments encountered and how were these events addressed, how effective were the BMPs in minimizing impacts from Project construction, and how the Corps addressed any adverse compliance monitoring finding.

ii. The Corps must record daily operations while dredging to ensure all BMPs are followed. In order to complete this task, the Corps will develop a standard tracking table for workers of the dredging vessels. The results of the tracking information will be included in summary form and as an appendix to the construction and maintenance annual reports (see Integrated Annual Report requirement, below).

b. Monitoring Activities:

i. An annual monitoring report will be completed for each monitoring action (MA-1 to MA-6). The following shall be included in the monitoring report for each monitoring action: (1) Overview of monitoring action; (2) monitoring data and results; (3) description of adverse impacts to ESA-listed salmonids and/or their habitats that were determined to be related to Project activities; and (4) recommendations to be reviewed by adaptive management team.

c. Ecosystem Restoration Features:

i. Upon completion of each restoration feature, the Corps will submit an monitoring report to NMFS. The report will include:

(1) Detailed discussion of monitoring results.
(2) Photographic documentation of environmental conditions at the project site before, during, and after project completion.
(3) Photographs will include general project location views and close-ups showing details of the project area and project, including pre and post construction.
(4) Each photograph will be labeled with the date, time, photo point, project name, the name of the photographer, and a comment describing the photograph's subject.
(5) Recommendations on methods to improve site-specific restoration activities.

d. Ecosystem Research Actions:

i. An annual research progress report, and a final report, shall be completed for each research action. Each final report shall clearly define research objectives, and report on research findings. Recommendations for additional research, or discussion of management implications, also shall be provided.

e. Integrated Annual Report:

i. The Corps shall provide an annual progress report that documents the Corps progress implementing all reasonable and prudent measures and their implementing terms and conditions. As appropriate, based on the Integrated Annual Report, NMFS will determine whether reinitiation of consultation is indicated.

If a dead, injured, or sick endangered or threatened species specimen is located during Project dredging, disposal, monitoring, research, or restoration activities, initial notification must be made to the National Marine Fisheries Service Law Enforcement Office, at the Vancouver Field Office, 600 Maritime, Suite 130, Vancouver, Washington 98661; phone: 360.418.4246.

Care should be taken in handling sick or injured specimens to ensure effective treatment and care or the handling of dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered and threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not disturbed.

13. MAGNUSON-STEVENS ACT

13.1 Background

On July 18, 2001, the NMFS received a letter from the Corps requesting essential fish habitat (EFH) consultation for the subject action pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and its implementing regulations (50 CFR 600). The objective of the EFH consultation is to determine whether the proposed action may adversely affect designated EFH for relevant species, and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH resulting from the proposed action.

13.2 Magnuson-Stevens Fishery Conservation and Management Act

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), requires the inclusion of EFH descriptions in Federal fishery management plans. In addition, the MSA requires Federal agencies to consult with NMFS on activities that may adversely affect EFH.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting the definition of essential fish habitat: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species' full life cycle (50 CFR 600.110). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

EFH consultation with NMFS is required for any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH. Section 305(b) of the MSA (16 U.S.C. 1855(b)) requires that:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH;
- NMFS shall provide conservation recommendations for any Federal or State activity that may adversely affect EFH;
- Federal agencies shall within 30 days after receiving conservation recommendations from NMFS provide a detailed response in writing to NMFS regarding the conservation recommendations. The response shall include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the conservation recommendations of NMFS, the Federal agency shall explain its reasons for not following the recommendations.

13.3 Identification of EFH

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). For the purposes of this analysis, this Opinion addresses potential effects to chinook and coho salmon.

In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon and California north of Point Conception to the Canadian border. Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

13.4 EFH Related to the Project

Upon withdrawal of the December 16, 1999, biological opinion, NMFS also withdrew its EFH analysis for ground fish and coastal pelagic species. At that time, there was not a finalized salmon EFH appendix to the Pacific Coast Salmon Plan that could be included in the 1999 biological opionion. Now that a final EFH appendix exists, this Opinion includes an EFH analysis and determination of potential adverse effects to chinook and coho salmon (see Sections 6. and 13.6 of this Opinion).

The Corps did not include their existing EFH response for ground fish and coastal pelagic species in their 2001 BA. Therefore, NMFS has requested, and the Corps has agreed, to address EFH for ground fish and coastal pelagic species as part of their upcoming supplemental EIS process for the Project. NMFS will review the information provided in the supplemental EIS as well as our previous correspondence with the Corps on this subject and provide a new determination at that time.

13.5 The Proposed Action

The proposed action and action area are detailed above in Section 3.2 of this Opinion. The action area includes habitats that have been designated as EFH for various life-history stages of chinook and coho salmon.

13.6 Effects of Proposed Action

As described in detail in Section 6., of this Opinion, Effects of the Proposed Action, the proposed activities may result in detrimental short- and long-term adverse effects to a variety of habitat parameters. The adverse effects to EFH for salmon are the same as those described to ESA-listed salmonids. Therefore, the ESA effects analysis in this Opinion addresses any potential Project impacts to salmon EFH.

13.6 Conclusion

NMFS believes that the proposed action may adversely affect the EFH for chinook and coho salmon species.

13.7 EFH Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. While NMFS understands that the proposed dredging and disposal Impact Minimization Measures and Best Management Practices identified in Chapter 3. of the 2001 BA conservation measures described in the will be implemented by the Corps , it does not believe that these measures are sufficient to address the adverse impacts to EFH described above. However, the Conservation Measures outlined in Section 10. of this Opinion and all the reasonable and prudent measures and Terms and Conditions outlined in Section 12. of this Opinion are generally applicable to designated EFH for chinook and coho salmon and address these adverse effects. Consequently, NMFS recommends that they be adopted as EFH conservation measures.

13.8 Statutory Response Requirement

Please note that the Magnuson-Stevens Act (section 305(b)) and 50 CFR 600.920(j) requires the Federal agency to provide a written response to NMFS after receiving EFH conservation recommendations within 30 days of its receipt of this letter. This response must include a description of measures proposed by the agency to avoid, minimize, mitigate or offset the adverse impacts of the activity on EFH. If the response is inconsistent with a conservation recommendation from NMFS, the agency must explain its reasons for not following the recommendation.

13.9 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if either action is substantially revised or new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920).

14. REFERENCES

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